CHAPTER 57

Examination of the Musculoskeletal System

KEY TEACHING POINTS

- In patients with shoulder pain, the presence of a painful arc increases the probability of rotator cuff tendinitis, and a positive dropped arm test and infraspinatus weakness increase the probability of rotator cuff tear. Combinations of findings increase accuracy of diagnosing rotator cuff tear.
- In patients with hip pain, the following findings increase probability of hip osteoarthritis: limitation of internal rotation (<15 degrees), posterior hip pain during a squat, and groin pain during hip abduction or adduction.
- In patients with knee pain, the following findings increase the probability of knee osteoarthritis: palpable osteophytes, genu varum, and stiffness lasting less than 30 minutes.
- In patients with trauma to the knee, all of the traditional signs of ligament injuries (drawer signs, Lachman sign, collateral ligament laxity tests) are accurate when positive.
- In patients with blunt trauma to the knee, ankle, or midfoot, Ottawa rules specific to each area accurately exclude clinically important fractures.
- Three signs accurately diagnosis Achilles tendon rupture: the calf squeeze test, the knee flexion test, and palpating a gap in the tendon itself.

Examination of the musculoskeletal system includes *inspection* (for joint swelling, redness, and deformity), *palpation* (for joint warmth, tenderness, and crepitus*), and investigation of the joint's *range of motion*. Of these tests, range of motion is the most sensitive indicator of joint disease. The normal range of motion of joints is presented in Table 57.1.

Joint pain may originate in the joint itself (i.e., articular disease) or in extra-articular structures, such as tendons, ligaments, bursae, or nerves. Articular disease characteristically causes swelling and tenderness that surrounds the entire joint and limits its entire repertoire of motion, during both active and passive movements. In contrast, extra-articular disease causes swelling and tenderness localized to particular regions of the joint, affecting some aspects of the joint's range of motion while sparing others. Extra-articular disease also tends to limit active joint movements (i.e., voluntary movements) more than passive ones (i.e., movements with the muscles relaxed).

* *Crepitus* is a vibratory sensation felt over joints during movement.

TABLE 57.1 Normal Range of Motion of Joints[1]

Joint	Flexion/Extension	Abduction/Adduction	Rotation
Shoulder	180 degrees	180 degrees (abduction) 45 degrees (adduction, across body)	90 degrees (internal rotation) 90 degrees (external rotation)
Elbow	150 degrees (humeroulnar)	—	180 degrees (radiohumeral)
Wrist and carpal joints	70 degrees (wrist extension) 80-90 degrees (palmar flexion)	50 degrees (ulnar deviation) 20-30 degrees (radial deviation)	—
Fingers (MCP, PIP, and DIP joints)	90 degrees (MCP) 120 degrees (PIP) 80 degrees (DIP)	30-40 degrees (MCP combined abduction/adduction)	—
Hip	10-20 degrees (extension) 120 degrees (flexion, knee flexed)	40 degrees (abduction) 25 degrees (adduction)	40 degrees (internal rotation) 45 degrees (external rotation)*
Knee	130 degrees	—	—
Ankle and feet	45 degrees (plantar flexion) 20 degrees (dorsiflexion)	—	30 degrees (inversion) 20 degrees (eversion)

*Internal and external rotation if hip and knee flexed; less if hip and knee extended.
DIP, Distal interphalangeal; *MCP*, metacarpophalangeal; *PIP*, proximal interphalangeal.

In joints lacking normal alignment, **dislocation** implies complete lack of contact between the two articular surfaces, whereas **subluxation** implies residual contact but abnormal alignment. In a **valgus deformity** the distal part of the limb is directed *away* from the body midline (e.g., **genu valgum** of knock-knees; or **hallux valgus** of bunions). In a **varus deformity** the distal part is directed *toward* the body midline (e.g., **genu varum** of bowlegs). A **recurvatum deformity** describes abnormal hyperextension of a joint (e.g., **genu recurvatum** of back-kneed individuals, common in patients with chronic quadriceps weakness, see Chapter 7).

An attentive physical examination is fundamental to musculoskeletal diagnosis because, in contrast to other organ systems, the diagnostic standard for many musculoskeletal disorders *is* the bedside findings (Table 57.2 and Chapter 1). For example, in patients with symmetric arthritis of the wrists and hands, ulnar deviation of the metacarpophalangeal joints, and swan neck deformities of the fingers, the diagnosis of rheumatoid arthritis is almost certain whether or not the serologic rheumatoid factor is present (if absent, the patient has **seronegative rheumatoid arthritis**). Instead of focusing on such syndrome-defining findings (for which calculating likelihood ratios [LRs] is impossible), this chapter will focus on those disorders of the shoulder, hip, knee, and ankle for which diagnosis relies on clinical imaging or surgical findings (e.g., osteoarthritis and orthopedic injuries). Other chapters of this book review stance and gait (see Chapter 7), back pain (see Chapter 64), and hand pain (see Chapter 64).

TABLE 57.2 Abnormal Articular Findings and Implied Diagnosis*

Finding	Diagnosis
SHOULDER	
Inspection:	
Flattening of rounded lateral aspect of shoulder	Anterior dislocation
Swelling over anterior aspect	Glenohumeral synovitis; synovial cyst
ELBOW	
Inspection:	
Localized cystic swelling over olecranon	Olecranon bursitis
Swelling obscuring para-olecranon grooves	Elbow synovitis
Nodules over extensor surface of ulna	Gouty tophi; rheumatoid nodules
Palpation:	
Elbow pain and tenderness over lateral epicondyle	Lateral epicondylitis (tennis elbow)
Elbow pain and tenderness over medial epicondyle	Medial epicondylitis (golfer's elbow)
WRISTS AND CARPAL JOINTS	
Inspection:	
Firm, painless cystic swelling, often located over volar or dorsal wrist	Ganglion (synovial cyst)
Thickening of palmar aponeurosis, causing flexion deformity of MCP joints (fourth finger > fifth finger > third finger)	Dupuytren contracture
Abnormal prominence of distal ulna	Subluxation of ulna (from chronic inflammatory arthritis, especially rheumatoid arthritis)
Nonpitting swelling proximal to wrist joint, sparing joint itself; associated clubbing of digits	Hypertrophic osteoarthropathy
Special Tests:	
Flexion and extension of digits causes snapping or catching sensation in palm	Trigger finger (flexor tenosynovitis)
Finkelstein test: pain when patient makes fist with fingers over thumb and bends the wrist in an ulnar direction	Tenosynovitis of long abductor and short extensor of thumb (de Quervain stenosing tenosynovitis)
FINGERS	
Inspection:	
Loss of normal knuckle wrinkles	PIP or DIP synovitis
Loss of "hills and valleys" appearance of metacarpal heads	MCP synovitis
Ulnar deviation at metacarpophalangeal joints	Chronic inflammatory arthritis
Swan neck deformity (flexion at MCP joint, hyperextension of PIP joint, flexion of DIP joint)	Chronic inflammatory arthritis, especially rheumatoid arthritis
Boutonniere deformity (flexion of PIP, hyperextension of DIP)	Detachment of central slip of extensor tendon to PIP, common in rheumatoid arthritis
Osteophytes: Heberden nodes at DIP, Bouchard nodes at PIP	Osteoarthritis

Continued

TABLE 57.2 Abnormal Articular Findings and Implied Diagnosis*—cont'd

Finding	Diagnosis
Mallet finger: flexion deformity of DIP	Detachment of extensor tendon from base of distal phalanx or fracture
"Telescoping" or "opera-glass hand": shortening of digits and destruction of IP joints	Arthritis mutilans, in rheumatoid or psoriatic arthritis
HIP	
Inspection:	
Trauma, hip externally rotated	Femoral neck fracture; anterior dislocation
Trauma, hip internally rotated	Posterior dislocation
Pelvic tilt (imaginary line through the anterior iliac spines is not horizontal)	Scoliosis; anatomic leg-length discrepancy; hip disease
Palpation:	
Hip pain, tenderness localized over greater trochanter	Trochanteric bursitis
Hip pain, tenderness localized over middle third of inguinal ligament, lateral to femoral pulse	Iliopsoas bursitis
Hip pain and tenderness localized over ischial tuberosity	Ischiogluteal bursitis (weaver's bottom)
KNEE	
Inspection:	
Localized tenderness and swelling over patella	Prepatellar bursitis (housemaid's knees)
Generalized swelling of popliteal space	Baker cyst (enlarged semimembranosus bursa, which communicates with knee joint)
Genu varum and genu valgum	See text
Palpation:	
Knee pain and tenderness localized over medial aspect of upper tibia	Anserine bursitis
Distressed reaction if patella moved laterally (apprehension test)	Recurrent patellar dislocation
ANKLE AND FEET	
Inspection:	
Flattening of longitudinal arch	Pes planus
Abnormal elevation of medial longitudinal arch	Pes cavus
Outward angulation of great toe with prominence over medial first MTP joint (bunion)	Hallux valgus
Hyperextension of MTP joints and flexion of PIP joints	Hammer toes
Palpation:	
Nodules within Achilles tendon	Tendon xanthoma
Foot pain, localized tenderness over calcaneal origin of plantar fascia	Plantar fasciitis
Foot pain, localized tenderness over plantar surface of MT heads	Metatarsalgia

Continued

TABLE 57.2 Abnormal Articular Findings and Implied Diagnosis*—cont'd

Finding	Diagnosis
Forefoot pain, tenderness between second and third toes or between third and fourth toes	Morton interdigital neuroma
Ankle pain, dysesthesias of sole, aggravated by forced dorsiflexion and eversion of foot	Tarsal tunnel syndrome

*Special tests of the shoulder, hip, knee, and ankle are discussed in the text.
DIP, Distal interphalangeal; *MCP*, metacarpophalangeal; *MT*, metatarsal; *MTP*, metatarsophalangeal; *PIP*, proximal interphalangeal.

THE SHOULDER

I. INTRODUCTION

Shoulder pain is the third most common musculoskeletal complaint (the first two are back pain and knee pain).[2] The shoulder is vulnerable to pain because it is the only location in the human body where tendons (i.e., the rotator cuff tendons[†]) pass between moving bones (i.e., the acromion and humerus). This anatomy grants the shoulder great flexibility but also renders the rotator cuff tendons and accompanying bursa susceptible to inflammation, degeneration, and tears.

One popular method of classifying shoulder pain (see Table 57.3), based on the work of the British orthopedic surgeon James Cyriax,[3,4] distinguishes the causes of shoulder pain by location of pain, range of passive motion, strength of rotator cuff muscles, and **painful arc** (i.e., pain during arm elevation between the angles of 70 and 100 degrees, angles at which compression of the subacromial tissues is the greatest). Using this classification, 5% to 12% of patients with shoulder pain have capsular syndromes, 17% acute bursitis, 5% to 11% acromioclavicular syndromes, 47% to 65% subacromial syndromes, and 5% to 10% referred shoulder pain (e.g., cervical disc disease or myofascial pain).[5-8]

Nonetheless, some clinicians have questioned the utility and accuracy of this classification, for several reasons: (1) most shoulder syndromes are treated similarly with antiinflammatory medications, injections, and physical therapy, no matter what the diagnosis is[5]; (2) different shoulder syndromes are indistinguishable from the patient's perspective, causing similar pain and disability over time;[5,6] (3) if patients are examined a second time, the specific diagnosis often changes;[6] and (4) legions of bedside tests have been proposed to diagnose shoulder disorders (one website lists 129 tests[9]), and new ones continue to appear,[10] suggesting that a comprehensive understanding of shoulder pain is still lacking.

Nonetheless, the bedside examination continues to play an important role in patients with shoulder pain, especially in distinguishing intrinsic shoulder syndromes from disorders causing referred pain, and in identifying rotator cuff tears, a condition sometimes requiring surgical repair. These subjects are the focus of this section.

[†] The tendons of the supraspinatus, infraspinatus, subscapularis, and teres minor muscles make up the rotator cuff.

TABLE 57.3 Shoulder Syndromes

Syndrome	Location of Pain	Range of Passive Motion	Other Findings
Capsular syndromes Adhesive capsulitis Glenohumeral arthritis	Outer arm	Limited* (all motions limited, especially external rotation and abduction)	—
Acute bursitis†	Outer arm	Limited* (abduction especially limited)	—
Acromioclavicular pain	Point of shoulder	Normal	Tenderness of acromioclavicular joint Pain worse during adduction of arm across body
Subacromial syndromes† Rotator cuff tendonitis Rotator cuff tear	Outer arm	Normal	Painful arc Rotator cuff muscle strength: Normal in tendonitis Weak in rotator cuff tears

*One way to test for limitation of passive motion is to ask the patient to bend over and try to touch his or her toes. In those with normal shoulder passive motion, the arms dangle toward the floor.

†*Acute bursitis* and *subacromial disorders* both represent disorders of the subacromial space, but bursitis causes inflammation and swelling that is more acute and severe, thus limiting motion.

Based upon references 3-5.

II. THE FINDINGS

A. IMPINGEMENT SIGNS

Impingement signs reproduce subacromial pain by compressing the rotator cuff tendons between the head of the humerus and acromion. Of the many different impingement signs, the most popular are the **Neer impingement sign** and **Hawkins impingement sign** (Figs. 57.1 and 57.2). Both of these maneuvers were originally introduced to select patients for specific surgical procedures. The Neer maneuver forces the humerus (and overlying rotator cuff tendons) against the *anterior* acromion, which Neer proposed resecting (i.e., anterior acromioplasty) in patients with persistent pain.[11] The Hawkins maneuver forces the greater tuberosity of the humerus against the coracoacromial ligament (the ligament forming the anterior roof over the rotator cuff). If patients develop pain during this maneuver and surgery is contemplated, Hawkins believed the coracoacromial ligament should be resected.[13]

B. YERGASON SIGN

The **Yergason sign** (Fig. 57.3) has traditionally been associated with bicipital tendonitis, as if that were an isolated entity, but in fact most patients with inflammation of the biceps tendon also have disease of the rotator cuff. This occurs because

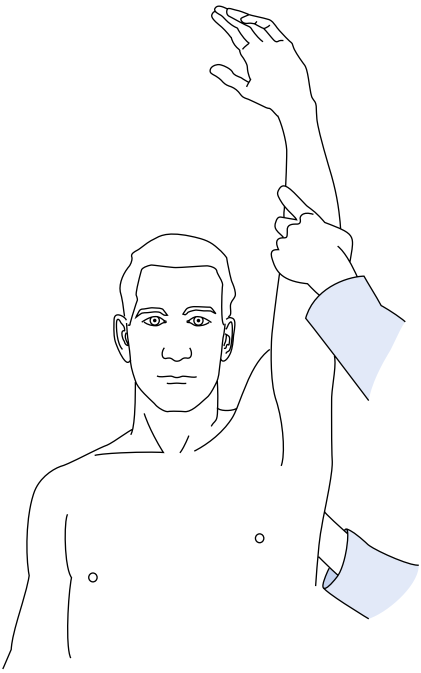


FIG. 57.1 NEER IMPINGEMENT SIGN.[11] The clinician prevents scapular motion with one hand and uses the other hand to raise the patient's arm in forward flexion, a position that presses the greater tuberosity of the humerus against the acromion.[11,12] Neer believed his sign was nonspecific (i.e., shoulder pains of all types worsened with this maneuver), but he taught that subacromial pain was the only shoulder syndrome whose positive impingement sign disappeared after injection of lidocaine into the subacromial space.

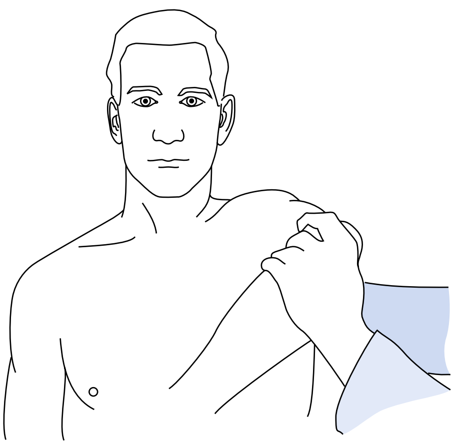


FIG. 57.2 HAWKINS IMPINGEMENT SIGN.[13] The clinician stands in front of the patient, flexes both the patient's shoulder and elbow to 90 degrees, and then internally rotates the patient's arm, a position that presses the greater tuberosity against the coracoacromial ligament.[12]

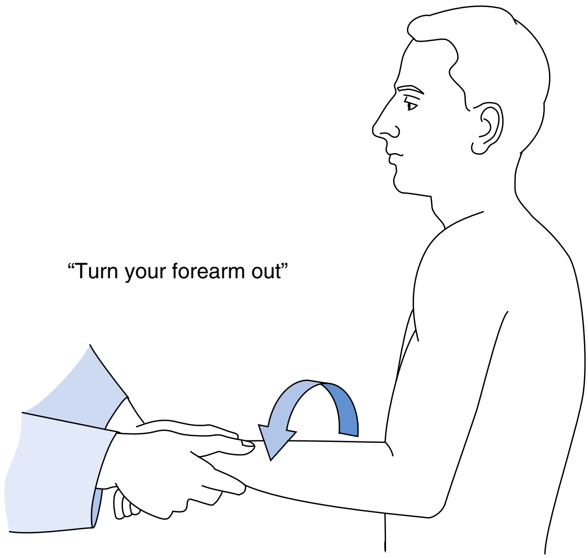


FIG. 57.3 YERGASON SIGN.[14] The clinician stands in front of the patient, flexes the patient's forearm 90 degrees at the elbow, and pronates the patient's wrist. The clinician then asks the patient to supinate the forearm against resistance (i.e., turn forearm in the direction of the arrow). Pain indicates a positive test, implying inflammation of the long head of the biceps tendon (the main supinator of the forearm).

progressive subacromial impingement causes wearing away of the supraspinatus tendon and underlying capsule, which then exposes the long head of the biceps tendon and subjects it to the same injurious forces. Indeed, most tears of the biceps tendon are associated with advanced rotator cuff disease.[11,15,16]

C. SPEED TEST

Like the Yergason sign, the **Speed test** (Fig. 57.4) was originally developed to identify pain originating in the bicipital tendon,[17] but studies apply the test now to the diagnosis of subacromial impingement syndromes in general.

D. MUSCLE ATROPHY

The clinician detects atrophy of the supraspinatus or infraspinatus muscles by inspecting the posterior scapula on the symptomatic side and noting any increased prominence of the scapular spine when compared with the contralateral side. Atrophy of these muscles may appear as soon as 2 to 3 weeks after a rotator cuff tear.

E. MUSCLE TESTING

The most important muscles to test in suspected tears of the rotator cuff are the supraspinatus muscle (involved in most rotator cuff tears) and the infraspinatus muscle (involved in 11% to 45% of tears).[16,18] The supraspinatus muscle abducts the shoulder, and the infraspinatus externally rotates it. Figs. 57.5 and 57.6 describe testing the strength of these muscles.

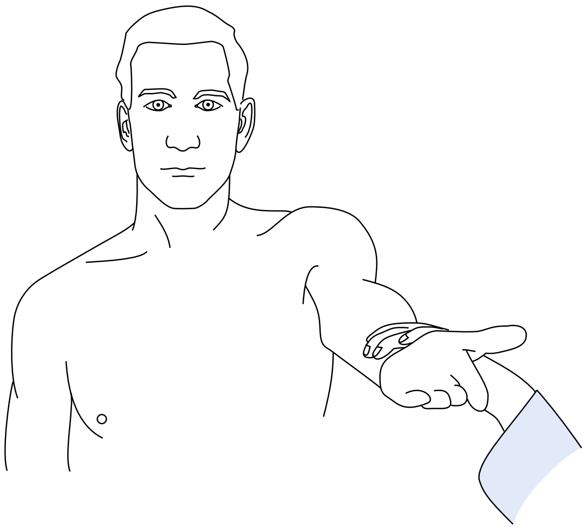


FIG. 57.4 SPEED TEST. The patient flexes the shoulder forward to 60 to 90 degrees, with his or her elbow extended and arm fully supinated (i.e., palm up), as the clinician applies a downward force. Pain in the shoulder (in the bicipital groove) is the positive response.

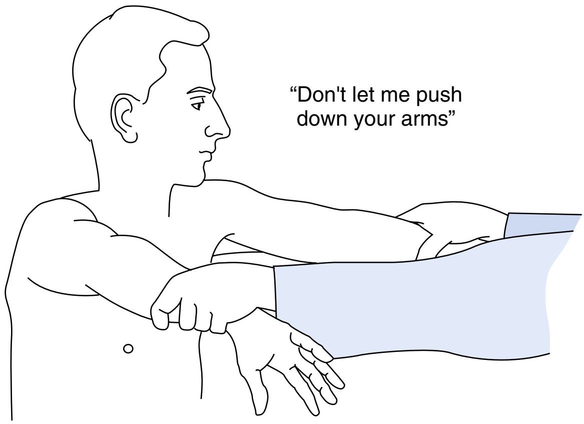


FIG. 57.5 SUPRASPINATUS TEST (EMPTY CAN TEST, JOBE TEST).[19] The clinician stands in front of the patient and elevates the patient's arms to 90 degrees in the plane of the scapula (i.e., *scaption*, midway between forward flexion and sideways abduction). The patient's arms are internally rotated with thumbs pointing down (as if emptying a can). The patient is asked to hold this position and resist attempts to lower the arms to the side. Some investigators propose testing the supraspinatus muscle in a slightly different way, with the arms externally rotated and thumbs pointing up (i.e., **full can test**), because this position causes less pain than the empty can test. In clinical studies, both versions have similar diagnostic accuracy.[18,20]

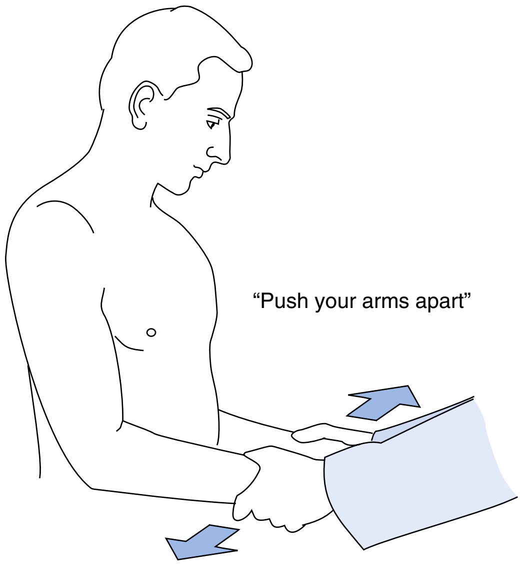


FIG. 57.6 **INFRASPINATUS TEST.** The clinician stands in front of the patient, and the patient's arms are at his or her side with elbows flexed 90 degrees and thumbs up. The examiner places his or her hands outside those of the patient's and directs the patient to move his arms out (i.e., direction of arrow), resisting the clinician's opposing inward pressure.[21]

F. DROPPED ARM TEST

The examiner abducts the patient's arm as far as possible and releases it, asking the patient to lower the arm slowly back down to the side. In patients with a positive test, indicating rotator cuff tear, the patient lowers the arm smoothly until approximately 100 degrees, after which the smooth movements become irregular and the arm may fall suddenly to the side.[22]

The dropped arm test becomes positive below angles of 100 degrees, not because the supraspinatus is the most powerful abductor at this angle,[‡] but because the rotator cuff muscles must be intact to pull the humeral head tightly against the glenoid fossa, creating a fulcrum that allows the deltoid to smoothly lower the arm.

G. PALPATING ROTATOR CUFF TEARS

Early descriptions of rotator cuff tears emphasized the importance of actually palpating the tear, just anterior to the acromial edge and through the deltoid muscle (Fig. 57.7).[23]

H. CROSSED BODY ADDUCTION TEST (SCARF TEST)

By crossing the arm horizontally maximally across the chest (Fig. 57.8), compression of the ipsilateral acromioclavicular joint occurs.

[‡] The supraspinatus muscle is responsible for only the initial 30 degrees of abduction, whereas the deltoid muscle (uninvolved in rotator cuff disease) accounts for abduction between 30 and 180 degrees.

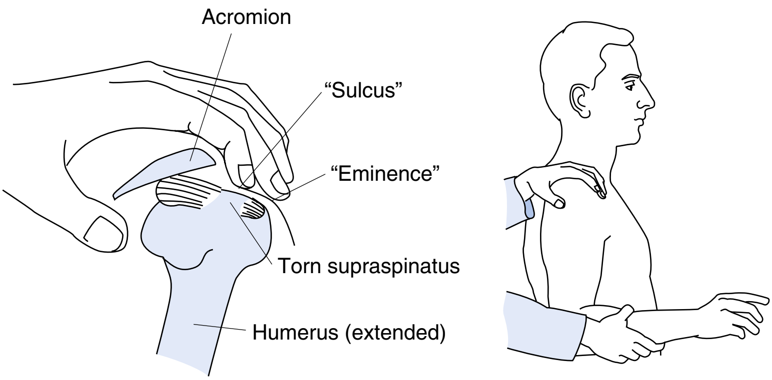


FIG. 57.7 PALPATION OF ROTATOR CUFF TEARS. The clinician stands behind the patient, and the patient’s arm is relaxed at the side with elbow flexed 90 degrees. The clinician palpates just below the patient’s acromion with one hand and holds the patient’s forearm with the other. The clinician then gently extends the patient’s arm as far as possible and rotates the shoulder internally and externally to fully reveal the greater tuberosity and attached tissues. In patients with tears of the supraspinatus tendon (which inserts on the greater tuberosity), the clinician detects both an abnormal eminence and an abnormal sulcus posterior to this eminence. The abnormal eminence is the greater tuberosity with attached remnant of tendon, and the sulcus just behind it is the actual rent in the supraspinatus tendon. Comparison with the contralateral shoulder helps to determine whether the suspected tear is real or not.

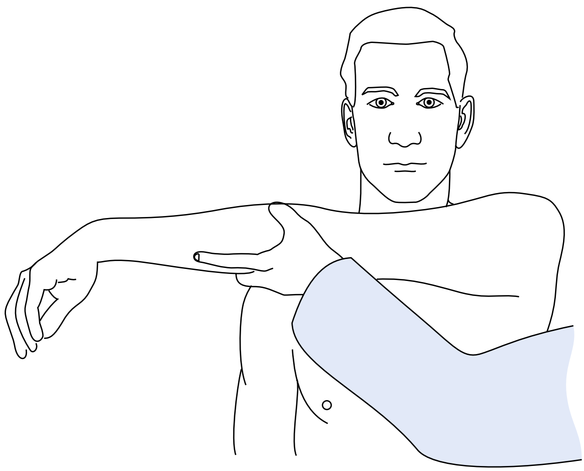


FIG. 57.8 CROSSED BODY ADDUCTION TEST. The clinician maximally adducts the patient’s arm (ipsilateral to the symptomatic shoulder) across the patient’s chest. Pain in the symptomatic acromioclavicular joint is the positive response.

III. CLINICAL SIGNIFICANCE

A. ACROMIOCLAVICULAR JOINT PAIN

In patients with shoulder pain a positive crossed body adduction test increases probability of acromioclavicular joint pain (LR = 3.7; EBM Box 57.1) and its absence decreases it (LR = 0.3). Acromioclavicular joint tenderness and compression tenderness are diagnostically unhelpful (LRs not significant).

B. ROTATOR CUFF TENDONITIS

According to the LRs in EBM Box 57.1, the findings that increase probability of rotator cuff tendonitis the most are positive painful arc (LR = 2.9), Yergason sign (LR = 2.8), and positive Speed test (LR = 1.9). The diagnostic accuracy of Yergason sign and Speed test emphasizes again the association between biceps tendon pain and rotator cuff disease (see the section on Yergason sign).

The presence of Neer or Hawkins impingement sign fails to change the probability of rotator cuff tendonitis much (LRs = 1.6 to 1.7), simply because shoulder pain of all types worsens during these maneuvers (i.e., specificity is low, and there are many false positives. Nonetheless, these studies did not repeat the impingement signs after lidocaine injection as Neer originally proposed, a maneuver that might improve specificity). The *absence* of Hawkins sign (LR = 0.3) and the *absence of* both impingement signs (LR = 0.1) significantly *decreases* probability of subacromial disease.

C. ROTATOR CUFF TEARS

1. INDIVIDUAL FINDINGS

In patients with shoulder pain, the bedside findings increasing the probability the most are age of 60 years or older (LR = 3.2), positive dropped arm test (LR = 2.9), and infraspinatus weakness (LR = 2.6). The positive supraspinatus test increases probability slightly, and diagnostic accuracy is similar whether the clinician regards the positive response to be weakness (LR = 2) or pain (LR = 1.7). Age of 39 years or younger (LR = 0.1) decreases probability of rotator cuff tear.

Although the reported diagnostic accuracy of palpating actual rents in the supraspinatus tendon is impressive (positive LR = 10.2, negative LR = 0.1; see EBM Box 57.1), these LRs have been derived from examinations by orthopedic surgeons who have comprehensive understanding of the anatomy of the shoulder and considerable experience treating shoulder pain.[32,33] Whether other practitioners will duplicate this accuracy is unknown.

2. COMBINED FINDINGS

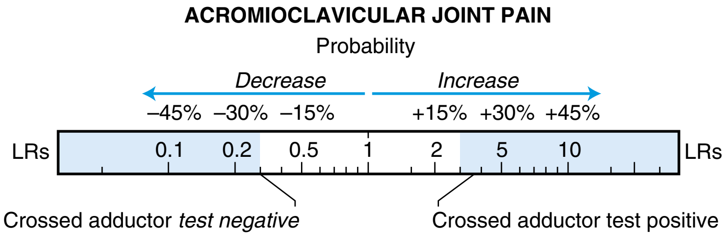
Two investigations of rotator cuff tears that combined clinical findings demonstrate superior diagnostic accuracy. Each focused on three clinical findings. Murrell[22] combined (1) impingement signs, (2) supraspinatus weakness, and (3) infraspinatus weakness, and Park[27] combined (1) Hawkins sign, (2) painful arc, and (3) infraspinatus weakness. When all three signs are present, the probability of rotator cuff tear is greatly increased (LR = 48 for the Murrell findings; LR = 15.9 for the Park findings; EBM Box 57.2), whereas when all three signs are absent, probability is greatly diminished (LR = 0.02 for the Murrell findings; LR = 0.2 for the Park findings).

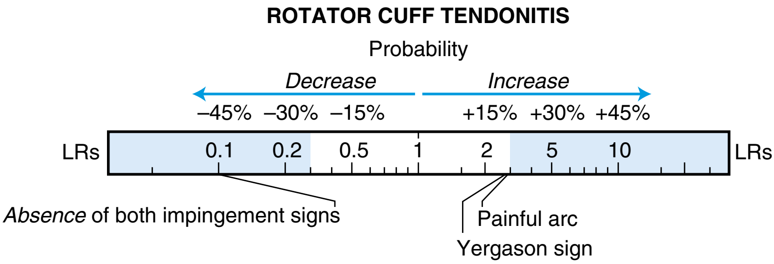
EBM BOX 57.1
*Shoulder Pain—Individual Findings**

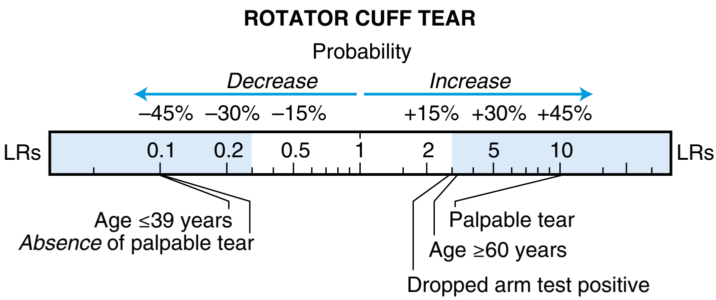
Finding (Reference)†	Sensitivity (%)	Specificity (%)	Likelihood Ratio‡ if Finding Is	
			Present	Absent
Detecting Acromioclavicular Joint Pain				
Acromioclavicular joint tenderness[8]	96	10	NS	NS
Tenderness with compression of acromoclavicular joint[8]	79	50	NS	NS
Crossed body adduction test[24]	77	79	**3.7**	**0.3**
Detecting Rotator Cuff Tendinitis				
Neer impingement sign[25-28]	68-89	32-69	1.6	0.5
Hawkins impingement sign[25-28]	72-93	26-66	1.7	**0.3**
Hawkins or Neer impingement sign[26]	96	41	1.6	**0.1**
Yergason sign[25]	37	87	2.8	0.7
Speed test[25,27]	38-69	55-83	1.9	0.7
Painful arc[25,27,28]	32-74	80-82	2.9	NS
Detecting Rotator Cuff Tear—Individual Findings				
Age[22]				
≤39 years	5	58	**0.1**	—
40-59 years	34	—	NS	—
≥60 years	62	81	**3.2**	—
Supraspinatus atrophy[21]	55	73	2.0	0.6
Infraspinatus atrophy[21]	55	73	2.0	0.6
Painful arc[21,27,29]	39-97	10-84	NS	0.5
Neer impingement sign[26,27,29]	59-88	43-82	1.7	NS
Hawkins impingement sign[26,27,29]	53-83	48-77	1.6	0.6
Supraspinatus testing causes pain[16,18,20]	63-85	52-60	1.7	0.4
Supraspinatus weakness[18,20,21,27,29-31]	32-84	51-89	2.0	0.6
Infraspinatus weakness[21,27,29]	16-76	57-84	2.6	0.6
Dropped arm test[22,27,29]	6-35	87-98	2.9	NS
Palpable tear[32,33]	91-96	75-97	**10.2**	**0.1**

Continued

*Diagnostic standard: For *acromioclavicular joint pain,* reduction of pain after injecting lidocaine into the acromioclavicular joint; for *rotator cuff tendonitis,* reduction of pain after injection of the subacromial space with lidocaine[25] or subacromial bursitis at arthroscopy;[26-28] for *rotator cuff tear,* arthrography,[21,27] magnetic resonance imaging,[18,20,29] ultrasonography,[31] or surgery (arthroscopy or open repair).[16,22,26,30,32,33]
†Definition of findings: For *tenderness with compression of the acromioclavicular joint*, the clinician stands behind the patient and compresses the joint by placing his or her thumb over the patient's posterolateral acromion and index/middle fingers on the patient's midclavicle.[8]
‡Likelihood ratio (LR) if finding present = positive LR; LR if finding absent = negative LR.
NS, Not significant.
Click here to access calculator







THE HIP

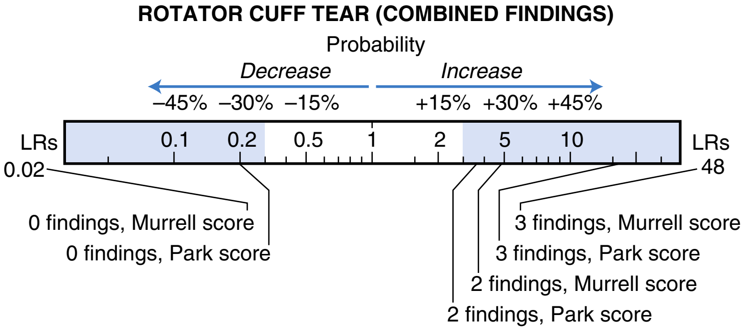
I. INTRODUCTION

Hip pain may result from a variety of disorders, including hip arthritis, sacroiliac disease, extra-articular disease (e.g., trochanteric bursitis, iliopsoas bursitis), neurogenic causes (e.g., meralgia paresthetica, sciatica), and, rarely, miscellaneous distant disorders (e.g., hernia).

EBM BOX 57.2
*Shoulder Pain—Combined Findings**

Finding (Reference)	Sensitivity (%)	Specificity (%)	Likelihood Ratio† if Finding Is	
			Present	Absent
Detecting Rotator Cuff Tear				
Number of findings present (Murrell): (1) Impingement signs, (2) supraspinatus weakness, (3) infraspinatus weakness[22]				
3 findings	24	100	**48.0**	—
2 findings	37	—	**4.9**	—
1 finding	39	—	NS	—
0 findings	1	52	**0.02**	
Number of findings present (Park): (1) Hawkins sign, (2) painful arc, (3) infraspinatus weakness[27]				
3 findings	33	98	**15.9**	—
2 findings	35	—	**3.6**	—
1 finding	24	—	NS	—
0 findings	9	42	**0.2**	

*Diagnostic standard: For *rotator cuff tear,* arthroscopy.[22,27]
†Likelihood ratio (LR) if finding present = positive LR; LR if finding absent = negative LR.
NS, Not significant.
Click here to access calculator



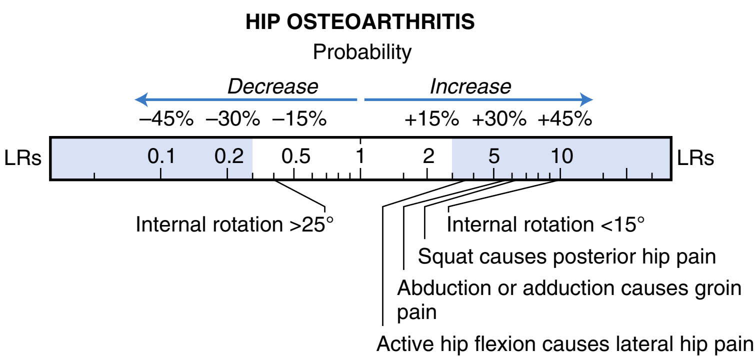
II. THE FINDINGS

The hip joint lies deep in the lower pelvis, surrounded by large muscles that protect it from direct contact with the external world, thus limiting the development of well-localized somatic sensations. Consequently, some patients with hip arthritis develop groin pain, but many experience pain at distant sites in the cutaneous distribution of nerves innervating the hip joint capsule, such as the thigh and knee (obturator and femoral nerves) or buttock (sciatic nerve). Unlike extra-articular causes of hip pain (e.g., trochanteric bursitis), hip disease affects the entire repertoire of hip motion, including flexion, extension, abduction, adduction, and internal and external rotation.

EBM BOX 57.3
Diagnosis of Osteoarthritis, in Patients With Hip Pain

Finding (Reference)	Sensitivity (%)	Specificity (%)	Likelihood Ratio† if Finding Is Present	Likelihood Ratio† if Finding Is Absent
Squat causes pain in posterior hip[34]	24	96	**6.1**	NS
Abduction or adduction causes groin pain[34]	33	94	**5.7**	NS
Active hip flexion causes lateral hip pain[34]	43	88	**3.6**	NS
Active hip extension causes hip pain[34]	52	80	2.7	0.6
Passive internal rotation				
≤25 degrees[34]	76	61	1.9	0.4
<15 degrees[35]	39	96	**9.9**	0.6

*Diagnostic standard: For *diagnosis of osteoarthritis*, Kellgren–Lawrence score on plain radiographs ≥2[34] or presence of radiographic osteophytes and joint space narrowing.[35]
†Likelihood ratio (LR) if finding present = positive LR; LR if finding absent = negative LR.
NS, Not significant.
Click here to access calculator



Many patients with hip disease develop a characteristic limp, the **coxalgic gait** (see Chapter 7).

III. CLINICAL SIGNIFICANCE

In a study of 78 patients presenting with unilateral hip pain,[34] pain localized to the ipsilateral buttock (LR = 6.7) or groin (LR = 3.6) increased the probability of hip osteoarthritis. Additional findings increasing the probability of hip disease were posterior hip pain with squatting (LR = 6.1, EBM Box 57.3), groin pain with abduction or adduction (LR = 5.7), and hip pain with active flexion (LR = 3.6) or

TABLE 57.4 Ottawa Rule for Knee Fracture[37,38]

A knee radiograph is indicated (and the rule is positive) if *any* of the following are present:
Aged ≥55 years
Tenderness at head of fibula
Isolated tenderness of patella*
Inability to flex to 90 degrees
Inability to bear weight both immediately and in the emergency department (four steps)†

*No bone tenderness of knee other than patella.
†Unable to transfer weight twice onto each lower limb regardless of limping.

extension (LR = 2.7). In another study of 598 elderly patients with joint pain, limitation of hip internal rotation to less than 15 degrees was a compelling argument for hip osteoarthritis (LR = 9.9).[35]

THE KNEE

I. INTRODUCTION

Knee pain affects up to 13% of the adult population and is second only to back pain among musculoskeletal complaints.[36] Common causes include arthritis (osteoarthritis, rheumatoid arthritis, gout, and pseudogout), bursitis (prepatellar and anserine bursitis), and injuries to ligaments or menisci. Among patients presenting with knee trauma, 6% to 12% have significant fractures on knee radiographs,[37-45] and the most frequently injured internal structures are the medial collateral ligament, ACL, and menisci (injuries of the medial meniscus outnumber lateral ones by three to one).[46-51]

II. THE FINDINGS

A. OTTAWA RULES FOR KNEE FRACTURE

Based on study of more than 1000 patients with acute blunt injury to the knee, Stiell and others have identified five independent predictors of clinically significant knee trauma (Table 57.4).[38] In this study the "knee" was broadly considered to include the patella, head and neck of the fibula, proximal 8 cm of the tibia, and distal 8 cm of the femur; *significant trauma* implied an injury requiring orthopedic consultation, splinting, or surgery.

B. TESTS OF LIGAMENT INJURIES

The stability of the knee depends on the joint capsule and two pairs of ligaments: the medial and lateral collateral ligaments, and the ACL and PCL.[§] The clinician tests each of these four ligaments by stressing the knee in a direction that the intact ligament would normally resist (specific tests appear below). If no movement occurs during stress testing or if small movements occur but abruptly end with a firm stop

§ The crossed cruciate ligaments are named for their attachment to the tibial surface (i.e., the ACL crosses from the posterior femur to the anterior tibia; the PCL crosses from the anterior femur to the posterior tibia). "Cruciate" derives from Latin cruciatus, meaning "cross-shaped."

(i.e., a “hard” endpoint), the ligament is intact. If there is excessive laxity of movement or a “soft” or “mushy” endpoint, the ligament is damaged.

Blunt trauma to the outside of the knee is associated with injury of the medial collateral ligament; trauma to the inside of the knee suggests injury of the lateral collateral ligament. Twisting of the knee after planting the foot is the characteristic mechanism of ACL injury, whereas deceleration of the flexed knee on a hard surface (e.g., striking the knee against the dashboard in an automobile accident) often precedes PCL injury. The mechanism of meniscal injuries resembles that of ACL injuries—twisting the knee after planting the foot—but unlike ACL injuries which are associated with immediate knee swelling, meniscal injuries cause swelling that appears only after a delay of several hours (because the menisci are relatively avascular).[52,53]

1. ANTERIOR CRUCIATE LIGAMENT

The ACL prevents anterior subluxation of the tibia on the femoral head. There are three common tests for this ligament: the anterior drawer sign, Lachman sign, and the pivot shift sign (Figs. 57.9 to 57.11).

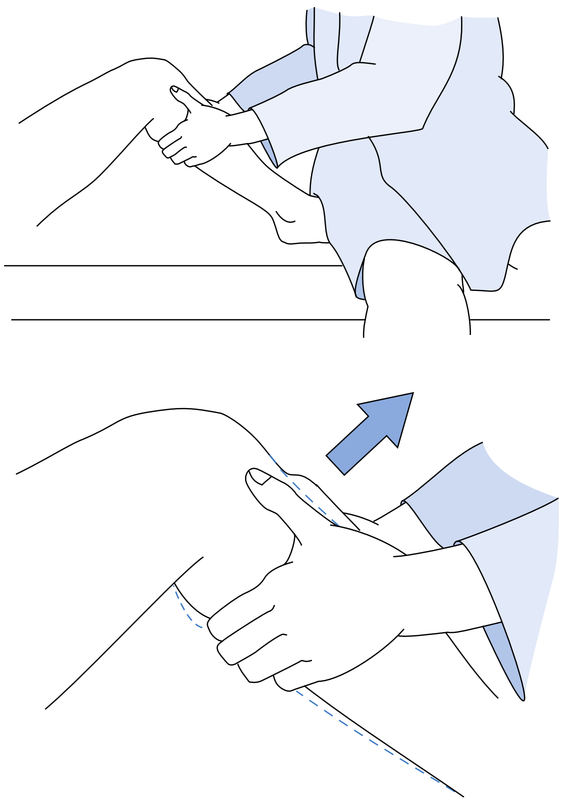


FIG. 57.9 ANTERIOR DRAWER SIGN. The patient lies supine with hip flexed at 45 degrees, knee flexed at 90 degrees, and foot flat on the table. The clinician sits on top of the patient's foot to stabilize it and then stresses the ACL ligament by grasping the patient's upper calf and pulling forward. Abnormal anterior subluxation of the tibia (*arrow*) with a soft end point is a positive test.

The **pivot shift sign** refers to the tendency of the tibia to sublux anteriorly in ACL-deficient knees when the knee is between 0 and 30 degrees of flexion, and the *spontaneous reduction* of the subluxed tibia as the knee is flexed past 40 degrees.[56,57] Patients with ACL injuries notice the pivot shift phenomenon themselves when they plant their foot with extended knee in front of them (e.g., stopping suddenly from a run causes the tibia to shift forward, producing the sensation of the knee "giving away"). Fig. 57.12 explains the mechanism of the pivot shift phenomenon. What specifically is responsible for the sudden reduction at 40 to 50 degrees is controversial, but most experts believe it is the pull of the iliotibial tract (whose action abruptly changes from a knee extensor to knee flexor beyond 40 degrees of flexion)[56,58,59] and the geometric peculiarities of the convex tibial surface.[57,60]

Descriptions of the **anterior drawer** sign have been found in writings from the 1870s.[61] The **Lachman test** was attributed to the American orthopedic surgeon John Lachman by one of his students in 1976,[62] although the same sign was described a century earlier by European clinicians.[61] Photographs of patients demonstrating their own pivot shift phenomenon were published in 1920,[63] but the pivot shift test was formally described in 1972.[64] The term itself is confusing, but according to Liorzou[58] it originated from an interview with a hockey player who stated, "When I pivot, my knee shifts."

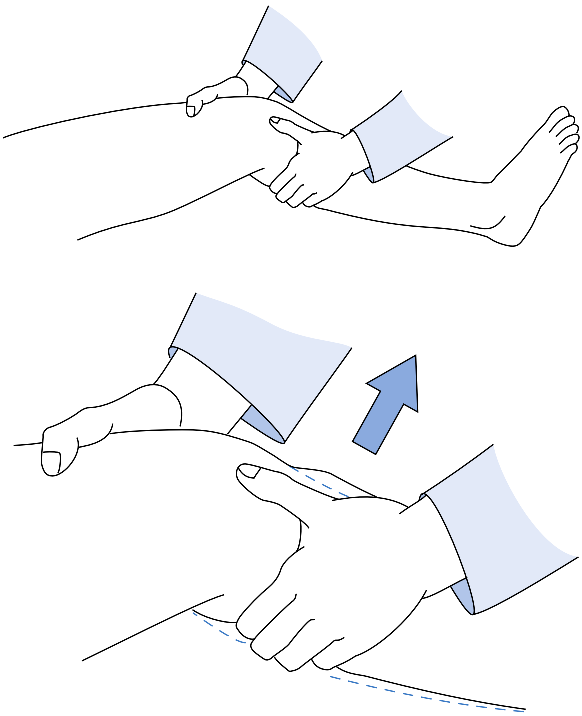


FIG. 57.10 LACHMAN SIGN. Lachman sign differs from the anterior drawer sign (see Fig. 57.9) by the position of the knee during testing. In Lachman test the hip is extended and the knee flexed at only 20 degrees. The clinician grasps the lower thigh with one hand and the upper calf with the other, pulling forward on the tibia to stress the ligament and reveal the abnormal anterior subluxation of the tibia (*arrow*).

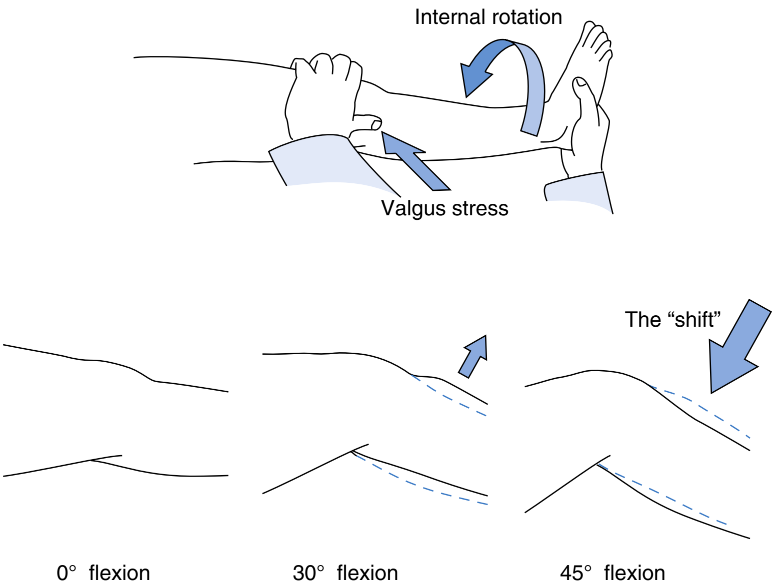


FIG. 57.11 **PIVOT SHIFT SIGN.** Many variations of this test have been published,[54] but the most common version begins with the patient supine, hip and knee extended. The clinician lifts the patient's leg, one hand over the fibula and the other at the ankle, pushing medially on the fibula (i.e., providing a valgus stress) and rotating internally the ankle and foot (and thus tibia). While maintaining these valgus and rotational stresses, the examiner slowly flexes the patient's knee. In the anterior cruciate ligament-deficient knee, the tibia subluxes anteriorly, almost imperceptibly, during the initial 0 to 30 degrees flexion with these applied forces (*small arrow*). However, at 40 to 50 degrees the tibia suddenly subluxes posteriorly (the shift), which constitutes a positive pivot shift test (and recalls for many patients the sensation of their "knee giving way").[55]

2. POSTERIOR CRUCIATE LIGAMENT

The PCL is the least likely internal structure of the knee to be injured.[47] Because this ligament resists posterior subluxation of the tibia on the femur, the conventional test is the **posterior drawer sign** (Fig. 57.13).

3. COLLATERAL LIGAMENTS

Injury to either collateral ligament is identified by applying a varus or valgus stress to the knee and noting abnormal movement when compared with the contralateral side. Testing is performed with the knee straight and at 20-degree flexion. Excessive movement during valgus stress indicates injury to the medial collateral ligament; excessive movement during varus stress indicates injury to the lateral collateral ligament.

C. TESTS OF MENISCAL INJURIES: THE MCMURRAY TEST

Tears of the *anterior* meniscus or large bucket-handle tears often displace tissue between the articular surfaces of the anterior tibia and femur, thus preventing full extension of the knee (or **locking**), a characteristic sign of meniscal injury.

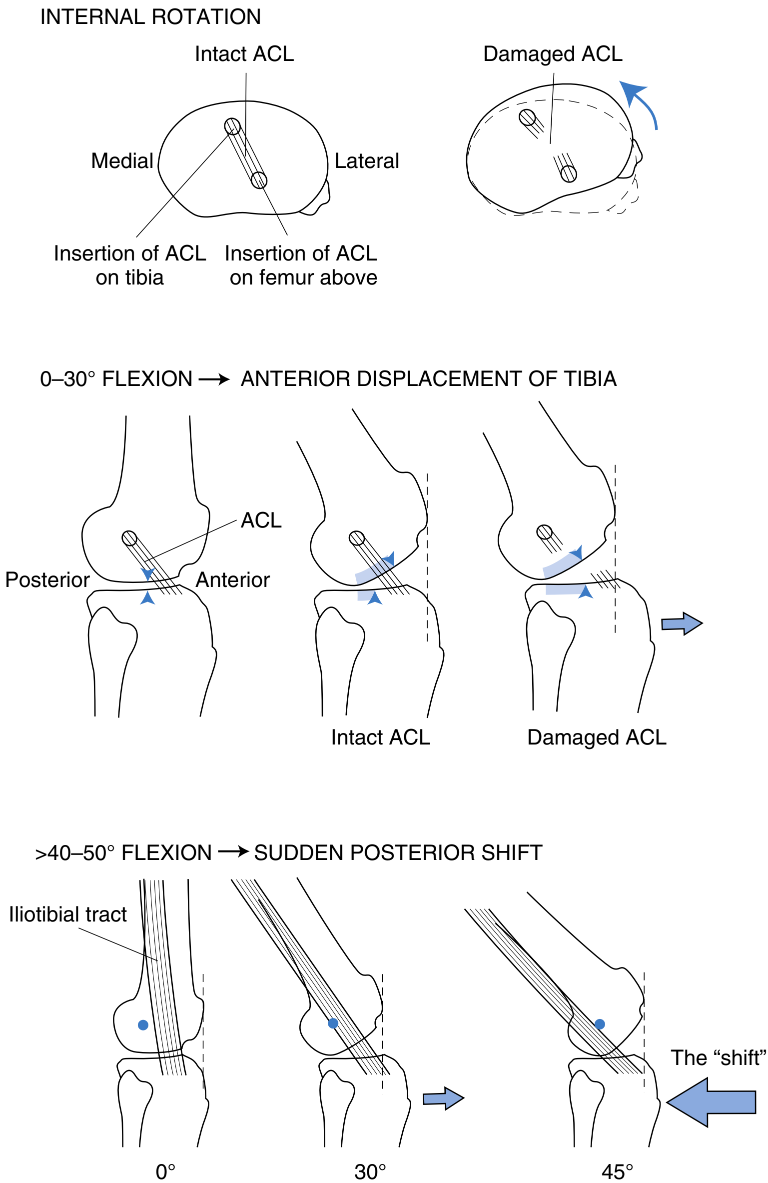

INTERNAL ROTATION
Intact ACL
Damaged ACL
Medial
Lateral
Insertion of ACL on tibia
Insertion of ACL on femur above
0–30° FLEXION → ANTERIOR DISPLACEMENT OF TIBIA
ACL
Posterior
Anterior
Intact ACL
Damaged ACL
>40–50° FLEXION → SUDDEN POSTERIOR SHIFT
Iliotibial tract
The “shift”
0°
30°
45°

FIG. 57.12 MECHANISM OF THE PIVOT SHIFT. The pivot shift phenomenon (i.e., positive test) refers to anterior displacement of the tibia with respect to the distal femur during the first 30 degrees of flexion and the sudden backward return of the tibia to its normal position after approximately 40 to 50 degrees flexion (see Fig. 57.11). This figure depicts what happens during internal rotation (*top row*), 0 to 30 degrees flexion (*middle row*), and beyond 40 to 50 degrees flexion (*bottom row*) in the ACL-deficient knee. (1) *Top row* (view of the tibial plateau from above): Because of its oblique orientation (*left*), the ACL is the key ligament resisting internal rotation of the tibia (this also explains why many ACL injuries occur after the athlete plants the foot and then rotates the knee). If the ACL is torn (*right*), internal rotation causes excessive anterior movement of the tibia (with respect to the femur). (2) *Middle row* (0 to 30 degrees flexion): The *left* figure shows the orientation of the ACL, and the blue arrowheads mark contiguous points on the femur and tibia when the knee is fully extended. During flexion of the knee when the ACL is intact (*middle* figure), the femur glides on the tibia, which results in a large surface area of the femur (light blue shading) contacting a relatively small area on the tibia. If the ACL is damaged (*right* figure), such gliding does not occur and instead the femur rolls back on the tibia, which displaces the tibia anteriorly (see *vertical dotted line*). A valgus stress is applied during the pivot shift test because it ensures contact between the lateral femoral condyle and lateral tibial plateau, as occurs during normal weight bearing. (3) *Bottom row:* When the knee is extended (*left*), the iliotibial tract is relaxed and lies in front of the axis of flexion (*dark circle*). At 30-degree flexion (*middle*), the iliotibial tract is still in front of the axis of flexion, but it becomes taut in the ACL-deficient knee as the tibia is displaced anteriorly. At 45-degree flexion (*right*), the iliotibial tract suddenly falls behind the axis of flexion, thus shifting from an extensor to a flexor of the knee and pulling the tibia backward into its normal alignment (the shift). *ACL,* Anterior cruciate ligament.

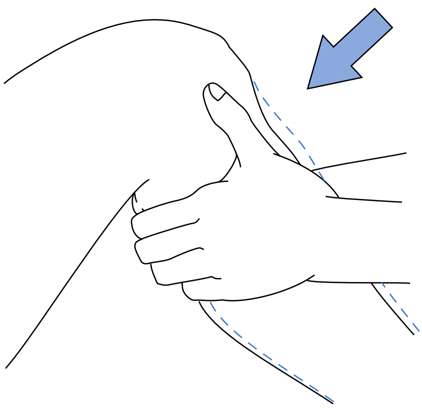


FIG. 57.13 POSTERIOR DRAWER SIGN. With the patient positioned as for the anterior drawer sign (see Fig. 57.9), the clinician pushes posteriorly on the patient's upper calf. In the posterior cruciate ligament-deficient knee, this force reveals an abnormal posterior tibial movement (*arrow*) with a soft endpoint.

Because tears of the posterior half of the meniscus are unlikely to cause locking and are therefore more difficult to detect, the British orthopedic surgeon McMurray proposed in 1949 additional diagnostic tests, one of which is now called the McMurray test (Fig. 57.14).[51]**

**One way to help to recall the correct positioning of the McMurray test: testing the medial (i.e., inner) meniscus is analogous to the patient squatting with both feet externally rotated; testing the lateral (outer) meniscus is analogous to the patient squatting with both feet internally rotated (i.e., pigeon-toed). One author has converted this squatting maneuver into a clinical test (the Ege test).[65]

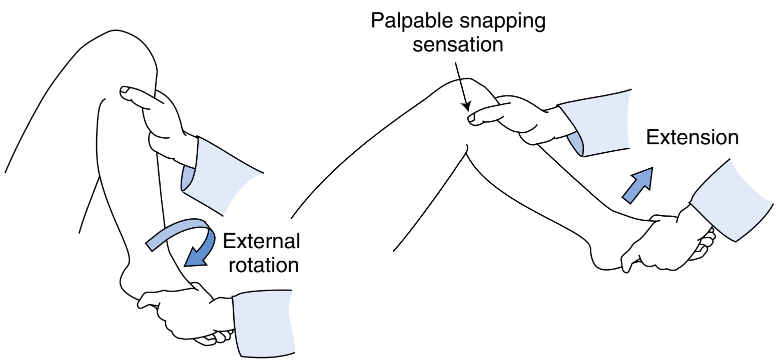


FIG. 57.14 THE MCMURRAY TEST. The clinician flexes the patient's knee fully against the buttock and rotates the tibia (by grasping the patient's foot and ankle). The purpose of rotation is to bring the torn meniscal fragment, located on the posterior half of the meniscus, *anterior* to the curved surface of the femoral condyle: *external* rotation brings forward the *medial* meniscus; *internal* rotation, the *lateral* meniscus. Therefore this figure depicts testing of the medial meniscus: the clinician places a free hand over the medial joint line, fully flexes the patient's knee, and then rotates the tibia externally. The clinician slowly extends the knee while maintaining this rotational force, thereby forcing the medial femoral condyle to glide forward on the tibia and *over* any torn fragment of meniscus. When the femur passes over the torn fragment, a palpable snapping sensation may be detected at the medial joint line (a positive test). To test the lateral meniscus, the clinician repeats the test while internally rotating the knee and palpating the lateral joint line. Popular orthopedic textbooks[66] and review articles[53,67,68] add varus and valgus stresses to their definitions of the McMurray test, although McMurray did not include this in his original description nor were they used in clinical studies testing the sign's accuracy (see EBM Box 57.6).

III. CLINICAL SIGNIFICANCE

A. DETECTING OSTEOARTHRITIS

In a study of 237 patients with various forms of chronic knee pain (i.e., osteoarthritis, rheumatoid arthritis, mensical or ligament injuries, osteonecrosis, gout, septic arthritis, and other assorted connective tissue disorders), the following findings increased the probability of osteoarthritis in the knee: palpable bony enlargement (LR = 11.8; EBM Box 57.4), genu varum deformity (LR = 3.4), stiffness lasting for less than 30 minutes (LR = 3), and presence of at least three of six characteristic findings listed in EBM Box 57.4 (LR = 3.1). The findings that decrease probability of osteoarthritis in the knee are fewer than three characteristic findings (LR = 0.1), morning stiffness lasting for more than 30 minutes (LR = 0.2), and absence of crepitus (LR = 0.2). The presence of valgus deformity is diagnostically unhelpful (LR not significant), occurring just as often in patients with osteoarthritis as alternative diagnoses.

In another study of 598 elderly patients with painful, stiff joints, inability to flex the knee more than 120 degrees accurately detected radiographic changes of osteoarthritis (sensitivity = 13%, specificity = 96%, positive LR = 3.4).[35]

B. DETECTING KNEE FRACTURE

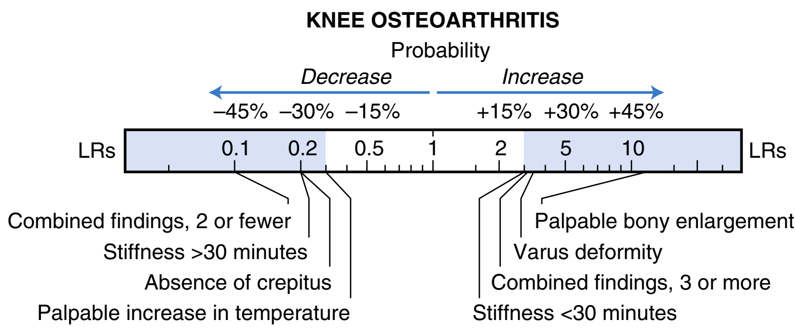
In patients presenting to emergency departments with knee trauma, the following findings increase probability of a clinically significant knee fracture: inability to flex the knee beyond 60 degrees (LR = 4.7; EBM Box 57.5), inability to bear weight

EBM BOX 57.4

Diagnosis of Osteoarthritis, in Patients with Chronic Knee Pain[69]

Finding (Reference)†	Sensitivity (%)	Specificity (%)	Likelihood Ratio‡ if Finding Is Present	Absent
Individual Findings				
Stiffness <30 min	85	72	**3.0**	**0.2**
Crepitus, passive motion	89	58	2.1	**0.2**
Bony enlargement	55	95	**11.8**	0.5
Palpable increase in temperature	14	52	**0.3**	1.6
Valgus deformity	24	83	NS	NS
Varus deformity	22	93	**3.4**	0.8
Combined findings: (1) Age >50 years; (2) Stiffness <30 min; (3) Crepitus; (4) Bony tenderness along margins of joint; (5) Bone enlargement; (6) No palpable warmth				
At least 3 out of 6:	95	69	**3.1**	**0.1**

*Diagnostic standard: For *diagnosis of osteoarthritis*, consensus of experts after review of patient's course, laboratory tests, and radiographs.
†Definition of findings: For *morning stiffness <30 min*, when applied only to patients complaining of morning stiffness and knee pain.
‡Likelihood ratio (LR) if finding present = positive LR; LR if finding absent = negative LR.
NS, Not significant.
Click here to access calculator



immediately after the injury and in the emergency department (LR = 3.6), tenderness at the head of the fibula (LR = 3.4), and age of 55 years or older (LR = 3). A negative Ottawa knee rule (i.e., lacking all five predictors from Table 57.4) greatly decreases probability of knee fracture (LR = 0.1).

C. DETECTING LIGAMENT AND MENISCAL INJURIES

Most studies of soft tissue injuries of the knee are vulnerable to both *selection bias* (i.e., only patients scheduled for surgery are enrolled) and *verification bias* (i.e., the surgeons who operated on the patients are also the clinicians who examined the

EBM BOX 57.5
*Clinically Significant Knee Fracture**

Finding (Reference)†	Sensitivity (%)	Specificity (%)	Likelihood Ratio‡ if Finding Is Present	Absent
Individual Findings				
Age ≥55 years[37,39]	23-48	87-88	**3.0**	NS
Joint effusion[37-39,70]	54-79	71-81	2.5	0.5
Ecchymosis[39]	19	91	NS	NS
Limitation of Knee Flexion[37-39]				
Not able to flex beyond 90 degrees	42-65	78-80	2.9	0.5
Not able to flex beyond 60 degrees	46-49	90	**4.7**	0.6
Isolated tenderness of patella[37-39]	25-31	85-89	2.2	0.8
Tenderness at head of fibula[37-39]	12-32	92-95	**3.4**	NS
Inability to bear weight, immediately and in emergency department[37-39]	46-58	81-89	**3.6**	0.6
Combined Findings				
Ottawa rule positive[37-45]	81-99	19-54	1.7	**0.1**

*Diagnostic standard: For *clinically significant knee fracture*, one requiring orthopedic consultation, splinting, or surgery (i.e., one >5 mm in breadth or one associated with complete tendon or ligament disruption).

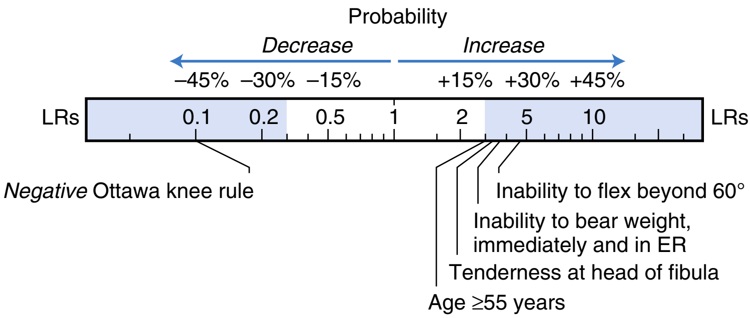
†Definition of findings: For *isolated tenderness of the patella,* no bony tenderness elsewhere on the knee;[37] for *inability to bear weight immediately and in emergency department,* unable to transfer weight twice onto each lower limb regardless of limping; for *Ottawa rule positive*, see Table 57.4.

‡Likelihood ratio (LR) if finding present = positive LR; LR if finding absent = negative LR.

NS, Not significant.

Click here to access calculator

CLINICALLY SIGNIFICANT KNEE FRACTURE



patients). Nonetheless, these biases may be less important than expected because other studies using independent diagnostic standards (e.g., magnetic resonance imaging [MRI])[71,72] reveal similar diagnostic accuracy for these clinical signs.

I. ANTERIOR CRUCIATE LIGAMENT INJURY

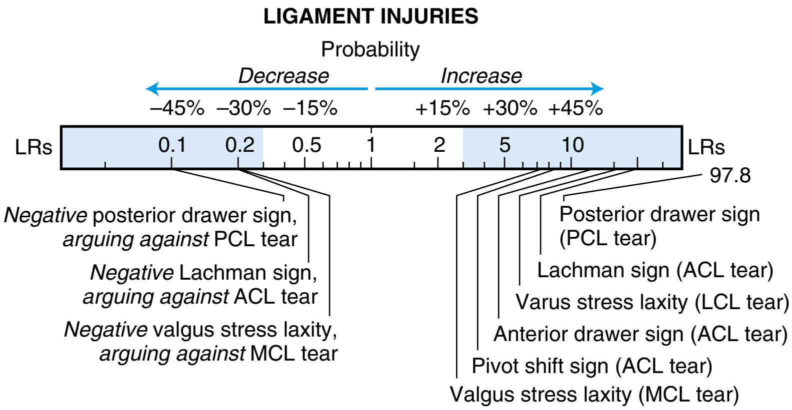
Any of the three physical tests of ACL injury, when positive, increase the probability of ACL injury: Lachman sign (LR = 19.5; EBM Box 57.6), anterior drawer sign (LR = 13.6), and pivot shift sign (LR = 8.8). However, only the *absence* of Lachman sign significantly decreases the probability of ACL injury (LR = 0.2).

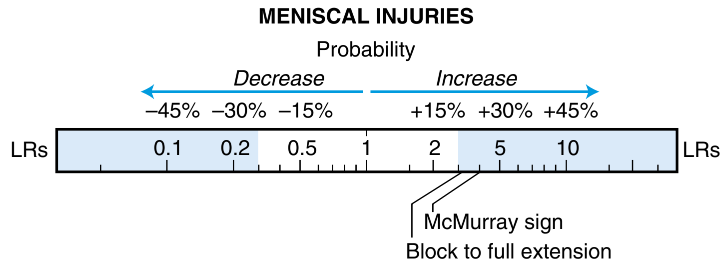
Lachman sign is more sensitive than the anterior drawer sign for three reasons:[62] (1) Hemarthrosis from acute ACL injury impairs knee flexion and thus prevents testing of the anterior drawer test. (2) Tense hamstring muscles, irritated from pain, directly oppose forward subluxation of the tibia during the anterior drawer sign (knee at 90 degrees) but not when the knee is at 20 degrees (i.e., at this angle the hamstring's pull is almost perpendicular to anterior subluxation of the tibia). (3) The thick posterior edge of the medial meniscus acts as a wedge against the curved femoral condyles and prevents anterior subluxation of the tibia when the knee is at 90 degrees (i.e., anterior drawer sign) but not when it is at 20 degrees (i.e., Lachman sign). In support of this last hypothesis, the sensitivity of the anterior drawer sign in one study increased from 50% to 100% after medial meniscectomy.[62]

EBM BOX 57.6
*Ligament and Meniscal Injuries**

Finding (Reference)	*Sensitivity (%)*	*Specificity (%)*	*Likelihood Ratio*† *if Finding Is Present*	*Likelihood Ratio*† *if Finding Is Absent*
Detecting Anterior Cruciate Ligament Tear				
Anterior drawer sign[48,62,71-75]	27-94	91-99	**13.6**	0.4
Lachman sign[48,62,71-73,75]	48-96	90-99	**19.5**	**0.2**
Pivot shift sign[48,71,73,75]	6-61	95-99	**8.8**	0.7
Detecting Posterior Cruciate Ligament Tear				
Posterior drawer sign[47,76]	90-95	99	**97.8**	**0.1**
Detecting Meniscal Injury				
McMurray sign[49,50,77-82]	17-80	77-98	**4.0**	0.6
Joint line tenderness[50,77-79,83,84]	55-92	30-83	1.8	0.5
Block to full extension[50]	44	86	**3.2**	0.7
Pain on forced extension[50,77]	47-51	67-70	1.6	0.7
Detecting Medial Collateral Ligament Injury				
Valgus stress laxity[48,85,86]	79-89	49-99	**7.7**	**0.2**
Detecting Lateral Collateral Ligament Injury				
Varus stress laxity[86]	25	98	**16.2**	NS

*Diagnostic standard: For *anterior cruciate tear,* MRI,[71,72] arthroscopy,[48,73,75] or surgery;[62,74] for *posterior cruciate tear*, arthroscopy; for *meniscal tear*, arthroscopy; for *collateral ligament tears*, arthroscopy[48,86] or MRI.[85]
†Likelihood ratio (LR) if finding present = positive LR; LR if finding absent = negative LR.
MRI, Magnetic resonance imaging; *NS*, not significant.
Click here to access calculator





In three clinical studies, expert clinicians combining the patient interview and clinical examination accurately diagnosed ACL tears (as detected by subsequent arthroscopy: sensitivity = 86% to 96%, specificity = 98% to 99%, positive LR = 49.6, negative LR = 0.1).[47,75,87]

2. POSTERIOR CRUCIATE TEAR

Two studies demonstrated the accuracy of bedside examination for posterior cruciate tear (positive LR = 97.8, negative LR = 0.1; see EBM Box 57.6). Unfortunately, neither study specifically identified the technique used at the bedside, although it almost certainly included the posterior drawer sign.

3. MENSICAL INJURY

Both the positive McMurray sign (LR = 4) and block to full extension of the knee (LR = 3.2) increase probability of a meniscal tear. However, no finding significantly decreases the probability, except for absence of joint line tenderness (LR = 0.5), which decreases probability only slightly. It is possible that the presence of joint line tenderness reflects accompanying injury of the joint capsule or collateral ligaments, rather than injury to the meniscus per se.

The above studies address diagnosis of *any* meniscus injury. Three studies have addressed whether expert clinicians combining the patient interview with clinical examination can accurately diagnose *and localize* the injured meniscus. In these studies, clinicians *were* slightly more accurate *ruling out* medial meniscus injury (sensitivity = 88% to 95%, specificity = 56% to 79%, positive LR = 3.4, negative LR = 0.1) and *ruling in* lateral meniscus injury (sensitivity = 51% to 55%, specificity = 90% to 96%, positive LR = 8.6, negative LR = 0.5).[47,87,88]

4. COLLATERAL LIGAMENTS

The presence of valgus stress laxity accurately indicates a tear of the medial collateral ligament (positive LR = 7.7; see EBM Box 57.6), and the presence of varus stress laxity indicates a tear of the lateral collateral ligament (LR = 16.2). The *absence* of valgus stress laxity *decreases* probability of a medial collateral ligament tear (LR = 0.2).

5. VARIABLES AFFECTING SENSITIVITY OF SIGNS

Signs of ligament injury are more likely to be positive if: (1) the ligament tear is complete, not partial,[67] (2) the injury is chronic, not acute,[89,90] and (3) multiple ligaments are injured (e.g., in ACL-deficient knees, the anterior drawer sign is more likely to be positive if the medial collateral ligament is also injured).[91] In addition, the degree to which the patient is relaxed influences the sensitivity of these signs, as illustrated by the observation that the sensitivity of most tests increases when patients are examined under anesthesia.[48,67,89,91]

6. PREDICTING THE NEED FOR KNEE SURGERY

If all knee injuries were managed conservatively (e.g., by rest, bracing, and physical therapy), the detailed bedside examination described above would have limited clinical utility. However, one study enrolled patients with knee pain and demonstrated that many of these physical signs—limited knee flexion (<120 degrees) or extension, medial or lateral joint line tenderness, a positive McMurray test, a positive Lachman test, and a positive anterior drawer sign—independently predicted whether an experienced orthopedic surgeon would recommend nonarthroplasty knee surgery to the patient.[92]

THE ANKLE

I. INTRODUCTION

In patients presenting with ankle or foot injuries to emergency departments, 8% to 14% are found to have a clinically significant fractures.[93-99] Achilles tendon rupture typically occurs during sports activities when the athlete forcibly plantarflexes the ankle ("pushes off" during running or jumping) or dorsiflexes it forcibly.[100]

II. THE FINDING

A. OTTAWA ANKLE AND MIDFOOT RULES

Stiell and others have developed a prediction rule for clinical significant injuries, called the Ottawa ankle rule.[101,102] This rule focuses on the presence of tenderness at four locations and whether the patient is able to bear weight both immediately after the accident and later in the emergency department (Fig. 57.15). Importantly,

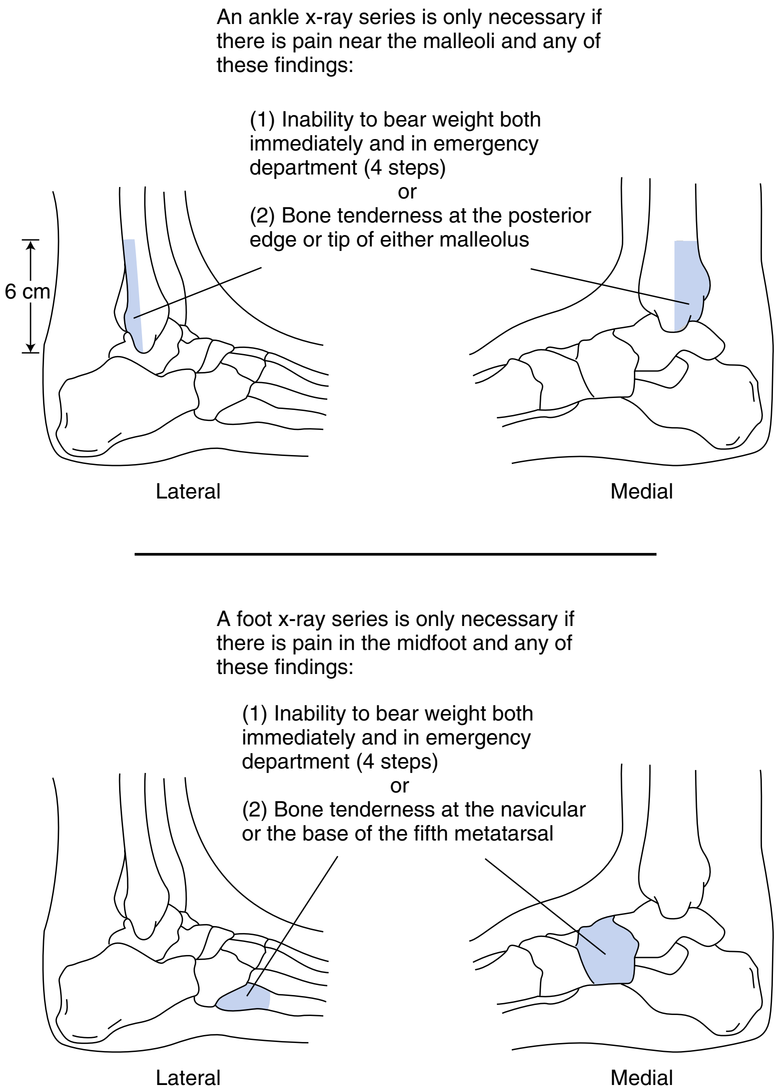


FIG. 57.15 OTTAWA RULE FOR ANKLE OR MIDFOOT FRACTURE. The rule for ankle pain is the top figure; the rule for midfoot pain is the bottom figure. The rule is positive if any indication for radiography is met. "Inability to take four steps" means the patient is unable to transfer weight twice onto each lower limb regardless of limping. Importantly, these rules apply *only* to patients with injury of the ankle or midfoot, and they exclude patients with injury to the body or tuberosities of the calcaneus. Based upon reference 101.

it applies only to patients with injury of the ankle (i.e., distal 6 cm of tibia and fibula and talus) and midfoot (i.e., navicular bone, cuboid, cuneiforms, anterior process of the calcaneus, and base of the fifth metatarsal) and *not* to injury of the body and tuberosities of the calcaneus or injury more than 10 days old.

B. ACHILLES TENDON RUPTURE

Many patients with ruptured Achilles tendons can still plantarflex the ankle, thus potentially misleading clinicians into thinking the Achilles tendon is intact (i.e., the tibialis posterior and peroneus muscles, which attach to the midfoot bones, plantarflex the foot). Consequently, special tests for Achilles tendon rupture have been developed. These tests, illustrated in Fig 57.16, rely on palpation of the injured tendon (**palpable gap**) or demonstration of absent tendon function (**calf squeeze test** and **knee flexion test**).

III. CLINICAL SIGNIFICANCE

A. ANKLE AND MIDFOOT FRACTURES

In patients with ankle injury, the finding of tenderness of the posterior medial malleolus increases probability of fracture (LR = 4.8; EBM Box 57.7), and the findings of negative Ottawa ankle rule (LR = 0.1) and ability to bear weight four steps in the emergency room (LR = 0.3) decrease probability. Specificity of the Ottawa ankle rule may improve by substituting *tuning-fork tenderness* for *tenderness with palpation*.[112]

In patients with midfoot pain, tenderness at the base of the fifth metatarsal bone increases the probability of fracture a small amount (LR = 2.9). A negative Ottawa foot rule argues for greatly decreased probability of midfoot fracture (LR = 0.1), though much of this argument rests on the absence of tenderness at the base of the fifth metatarsal bone (LR = 0.1).

Other studies combining the ankle and foot rules have confirmed their accuracy[93-99,113,114] and shown they reduce the need for radiographs by 14% to 34% and decrease medical costs and patient waiting times.[94,96-98,101,107,115-118]

B. ACHILLES TENDON RUPTURE

All three signs of Achilles tendon rupture accurately increase probability of a torn tendon if present (LRs = 6.2 to 13.5; EBM Box 57.8) and decrease probability if absent (LRs = 0.05 to 0.3).

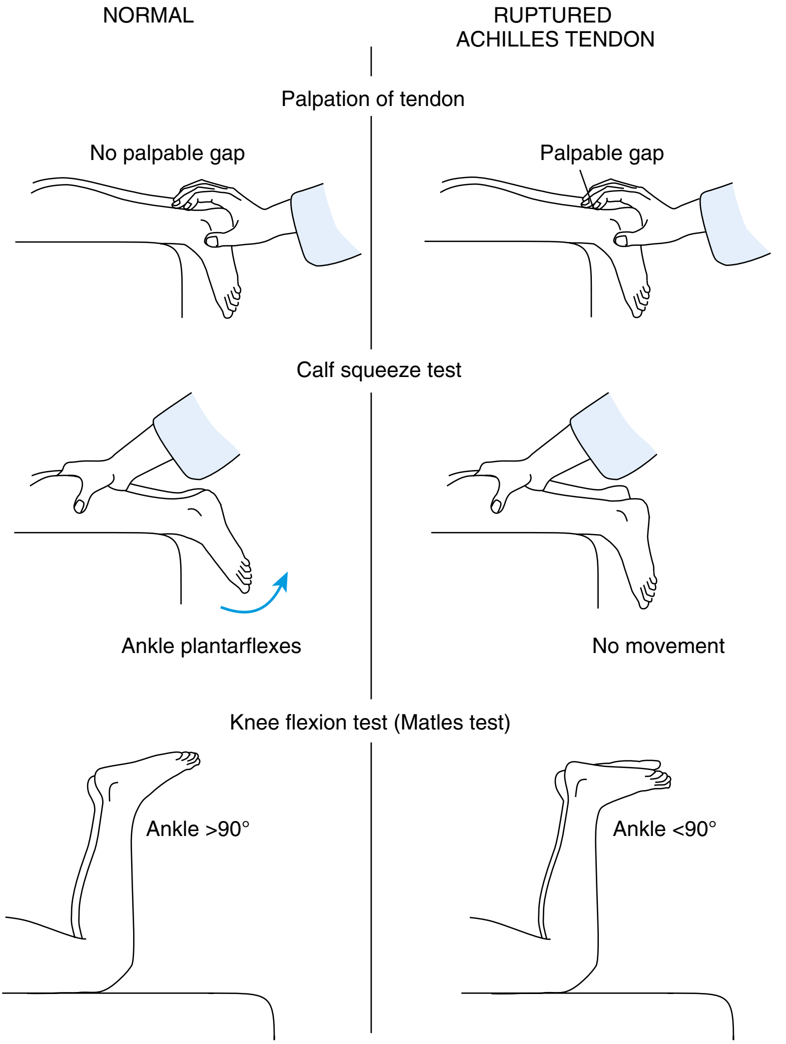


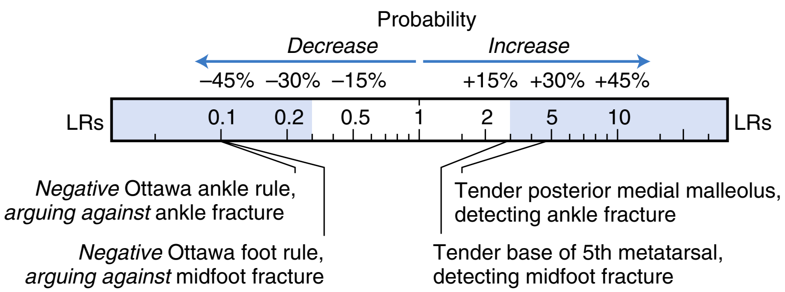
FIG. 57.16 TESTS FOR RUPTURE OF THE ACHILLES TENDON.[103] All tests are performed with the patient lying prone and his or her feet extending over the end of the examination table. The patient's asymptomatic side serves as a control (for each test, a patient with an intact Achilles tendon is depicted on the *left,* compared with a patient with a ruptured Achilles tendon on the *right*). **(1) Palpable gap in tendon** (*top*): The clinician gently palpates the course of the tendon, searching for gaps, which if present usually lie between 2 and 6 cm from the calcaneus.[100] **(2) Calf squeeze test** (**Simmonds–Thompson test**, *middle*): The clinician gently squeezes the patient's calf in its middle third and just below the place of widest girth, observing the ankle for movement. If the tendon is intact, the ankle should plantarflex. Absence of movement or minimal movement is a positive response. The normal plantar flexion of the ankle results from compression of the soleus muscle, which bows the Achilles tendon posteriorly.[104] **(3) Knee flexion test** (**Matles test,** *bottom*). The clinician observes the position of the patient's ankles as the patient flexes both knees to 90 degrees (the knees may be flexed individually or simultaneously). The ankle remains slightly plantar flexed if the tendon is intact; slight dorsiflexion or a neutral position of the ankle is the positive response. Thompson described the calf squeeze test in 1962,[100] pointing out that the test could be performed with the patient prone or kneeling on a chair. Simmonds described the identical test in 1957.[105] Matles described the knee flexion test in 1975.[106]

EBM BOX 57.7
*Ankle and Midfoot Fracture**

Finding (Reference)†	*Sensitivity (%)*	*Specificity (%)*	**Likelihood Ratio‡ if Finding Is** *Present*	*Absent*
Detecting Ankle Fracture				
Tenderness over posterior lateral malleolus[101,102]	69-76	65-74	2.4	0.4
Tenderness over posterior medial malleolus[101,102]	34-47	87-95	**4.8**	0.6
Inability to bear weight immediately after injury[101,102]	61-68	72-79	2.6	0.5
Inability to bear weight four steps in the emergency room[101,102]	80-85	64-70	2.5	**0.3**
Ottawa ankle rule[94,96,101,107-110]	94-100	16-44	1.5	**0.1**
Detecting Midfoot Fracture				
Tenderness at the base of the fifth metatarsal bone[101,102]	92-94	66-69	2.9	**0.1**
Tenderness of navicular bone[101,102]	3-12	74-90	0.4	NS
Inability to bear weight immediately[101,102]	18-28	74-82	NS	NS
Inability to bear weight four steps in the emergency room[101,102]	38-45	58-67	NS	NS
Ottawa foot rule[96,101,107-109,111]	88-99	21-79	2.1	**0.1**

*Diagnostic standard: For *clinically significant ankle or midfoot fracture,* bone fragments >3 mm in breadth (i.e., a size that might require plaster immobilization).
†Definition of findings: For *Ottawa ankle and foot rules*, see Fig. 57.15.
‡Likelihood ratio (LR) if finding present = positive LR; LR if finding absent = negative LR.
NS, Not significant.
Click here to access calculator

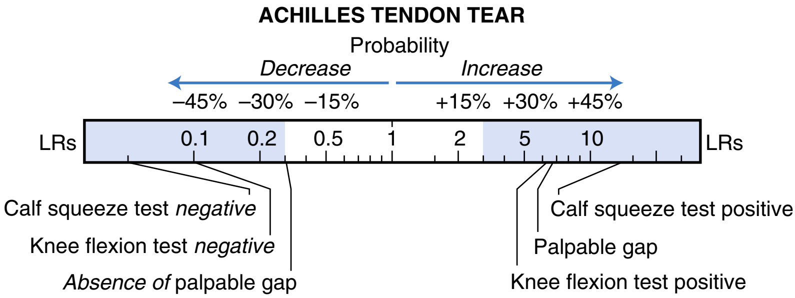
ANKLE AND MIDFOOT FRACTURE



EBM BOX 57.8
Achilles Tendon Tear[103*]

Finding (Reference)	*Sensitivity (%)*	*Specificity (%)*	**Likelihood Ratio**[†] **if Finding Is**	
			Present	***Absent***
Palpable gap in Achilles tendon	73	89	**6.8**	**0.3**
Calf squeeze test	96	93	**13.5**	**0.05**
Knee flexion test	88	86	**6.2**	**0.1**

*Diagnostic standard: For *Achilles tendon tear,* surgical findings or (in patients without surgery) ultrasonography or magnetic resonance imaging.
†Likelihood ratio (LR) if finding present = positive LR; LR if finding absent = negative LR
Click here to access calculator



The references for this chapter can be found on www.expertconsult.com.

This page intentionally left blank

REFERENCES

1. Beetham WP, Polley HF, Slocumb CH, Weaver WF. *Physical Examination of the Joints*. Philadelphia, PA: W. B. Saunders; 1965.
2. Urwin M, Symmons D, Allison T, et al. Estimating the burden of musculoskeletal disorders in the community: the comparative prevalence of symptoms at different anatomical sites, and the relation to social deprivation. *Ann Rheum Dis*. 1998;57:649–655.
3. Cyriax J. The shoulder. *Br J Hosp Med*. 1975;19:185–192.
4. Cyriax J. *Textbook of Orthopedic Medicine. Vol 1. Diagnosis of Soft Tissue Disorders*. 8th ed. London: Bailliere Tindall; 1982.
5. van der Windt DAWM, Koes BW, de Jong BA, Bouter LM. Shoulder disorders in general practice: incidence, patient characteristics, and management. *Ann Rheum Dis*. 1995;54:959–964.
6. van der Windt DAWM, Koes BW, Boeke AJP, Deville W, de Jong BA, Bouter LM. Shoulder disorders in general practice: prognostic indicators of outcome. *Br J Gen Pract*. 1996;46:519–523.
7. Vecchio P, Kavanagh R, Hazleman BL, King RH. Shoulder pain in a community-based rheumatology clinic. *Br J Rheumatol*. 1995;34:440–442.
8. Walton J, Mahajan S, Paxinos A, et al. Diagnostic values of tests for acromioclavicular joint pain. *J Bone Joint Surg Am*. 2004;86-A:807–812.
9. Funk L. Shoulder examination tests. In: Funk L, ed. 2015, <Shoulderdoc.co.uk>.
10. Carbone S, Gumina S, Vestri AR, Postacchini R. Coracoid pain test: a new clinical sign of shoulder adhesive capsulitis. *Int Orthop*. 2010;34:385–388.
11. Neer CS. Impingement lesions. *Clin Orthop*. 1983;173:70–77.
12. Valadie AL, Jobe CM, Pink MM, Ekman EF, Jobe FW. Anatomy of provocative tests for impingement syndrome of the shoulder. *J Shoulder Elbow Surg*. 2000;9(1):36–46.
13. Hawkins RJ, Kennedy JC. Impingement syndrome in athletes. *Am J Sports Med*. 1980;8(3):151–158.
14. Yergason RM. Supination sign. *J Bone Joint Surg Am*. 1931;13:160.
15. Beall DP, Williamson EE, Ly JQ, et al. Association of biceps tendon tears with rotatory cuff abnormalities: degree of correlation with tears of the anterior and superior portions of the rotator cuff. *Am J Roentgenol*. 2003;180:633–639.
16. Leroux JL, Thomas E, Bonnel F, Blotman F. Diagnostic value of clinical tests for shoulder impingement syndrome. *Rev Rhum Engl Ed*. 1995;62(6):423–428.
17. Crenshaw AH, Kilgore WE. Surgical treatment of bicipital tenosynovitis. *J Bone Joint Surg Am*. 1966;48A(8):1496–1502.
18. Itoi E, Kido T, Sano A, Uraymana M, Sato K. Which is more useful, the "full can test" or the "empty can test," in detecting the torn supraspinatus tendon? *Am J Sports Med*. 1999;27(1):65–68.
19. Jobe FW, Jobe CM. Painful athletic injuries of the shoulder. *Clin Orthop Clin Res*. 1983;173:117–124.
20. Kim E, Jeong HJ, Lee KW, Song JS. Interpreting postive signs of the supraspinatus test in screening for torn rotator cuff. *Acta Med Okayama*. 2006;60(4):223–228.
21. Litaker D, Pioro M, El Bilbeisi H, Brems J. Returning to the bedside: using the history and physical examination to identify rotatory cuff tears. *J Am Geriatr Soc*. 2000;48:1633–1637.
22. Murrell GAC, Walton JR. Diagnosis of rotator cuff tears. *Lancet*. 2001;357:769–770.
23. Codman EA. The classic: rupture of the supraspinatus tendon. *Clin Orthop*. 1990;254:3–26.
24. Chronopoulos E, Kim TK, Park HB, Ashenbrenner D, McFarland EG. Diagnostic value of physical tests for isolated chronic acromioclavicular lesions. *Am J Sports Med*. 2004;32(3):655–661.
25. Calis M, Akgun K, Birtane M, Karacan I, Calis H, Tuzun F. Diagnostic values of clinical diagnostic tests in subacromial impingement syndrome. *Ann Rheum Dis*. 2000;59:44–47.
26. MacDonald PB, Clark P, Sutherland K. An analysis of the diagnostic accuracy of the Hawkings and Neer subacromial impingement signs. *J Shoulder Elbow Surg*. 2000;9(4):299–301.
27. Park HB, Yokota A, Gill HS, Rassi GE, McFarland EG. Diagnostic accuracy of clinical tests for the different degrees of subacromial impingement syndrome. *J Bone Joint Surg Am*. 2005;87A(7):1446–1455.

28. Nanda R, Gupta S, Kanapathipillai P, Liow RYL, Rangan A. An assessment of the inter examiner reliability of clinical tests for subacromial impingement and rotator cuff integrity. *Eur J Orthop Surg Traumatol*. 2008;18:495–500.
29. van Kampen DA, van den Berg T, van der Woude HJ, et al. The diagnostic value of the combination of patient characteristicis, history, and clinical shoulder tests for the diagnosis of rotator cuff tear. *J Orthop Surg Res*. 2014;9:70.
30. Hertel R, Lambert SM, Gerber C. Lag signs in the diagnosis of rotator cuff rupture. *J Shoulder Elbow Surg*. 1996;5:307–313.
31. Kim HA, Kim SH, Seo YI. Ultrasonographic findings of painful shoulders and correlation between physical examination and ultrasonographic rotator cuff tear. *Mod Rheumatol*. 2007;17:213–219.
32. Lyons AR, Tomlinson JE. Clinical diagnosis of tears of the rotator cuff. *J Bone Joint Surg Br*. 1992;74B:414–415.
33. Wolf EM, Agrawal V. Transdeltoid palpation (the rent test) in the diagnosis of rotator cuff tears. *J Shoulder Elbow Surg*. 2001;10(5):470–473.
34. Sutlive TG, Lopez HP, Schnitker DE, et al. Development of a clinical prediction rule for diagnosing hip osteoarthritis in individuals with unilateral hip pain. *J Orthop Sports Phys Ther*. 2008;38(9):542–550.
35. Holla JFM, van der Leeden M, Roorda LD, et al. Diagnostic accuracy of range of motion measurements in early symptomatic hip and/or knee osteoarthritis. *Arthritis Care Res*. 2012;64:59–65.
36. Cunningham LS, Kelsey JL. Epidemiology of musculoskeletal impairments and associated disability. *Am J Public Health*. 1984;74:574–579.
37. Stiell IG, Greenberg GH, Wells GA, et al. Prospective validation of a decision rule for the use of radiography in acute knee injuries. *JAMA*. 1996;275:611–615.
38. Stiell IG, Greenberg GH, Wells GA, et al. Derivation of a decision rule for the use of radiography in acute knee injuries. *Ann Emerg Med*. 1995;26(4):405–413.
39. Richman PB, McCuskey CF, Nashed A, et al. Performance of two clinical decision rules for knee radiography. *J Emerg Med*. 1997;15(4):459–463.
40. Seaberg DC, Yealy DM, Lukens T, Auble T, Mathias S. Multicenter comparison of two clinical decision rules for the use of radiography in acute, high-risk injuries. *Ann Emerg Med*. 1998;32(1):8–13.
41. Emparanza JI, Aginaga JR. Validation of the Ottawa knee rules. *Ann Emerg Med*. 2001;38:364–368.
42. Tigges S, Pitts S, Mukundan S, Morrison D, Olson M, Shahriara A. External validation of the Ottawa knee rules in an urban trauma center in the United States. *Am J Roentgenol*. 1999;172:1069–1071.
43. Jalili M, Gharebaghi H. Validation of the Ottawa knee rule in Iran: a prospective study. *Emerg Med J*. 2010;27:849–851.
44. Jenny JY, Boeri C, Amrani HE, et al. Should plain radiography be routinely performed after blunt knee trauma? A prospective analysis. *J Trauma*. 2005;58:1179–1182.
45. Cheung TC, Tank Y, Breederveld RS, Tuinebreijer WE, Lange-de Klerk ESM, Derksen RJ. Diagnostic accuracy and reproducibility of the Ottawa knee rule vs. the Pittsburgh decision rule. *Am J Emerg Med*. 2013;31:641–645.
46. Simonsen O, Jensen J, Mouritsen P, Lauritzen J. The accuracy of clinical examination of injury of the knee joint. *Injury*. 1984;16:96–101.
47. O'Shea KJ, Murphy KP, Heekin RD, Herzwurm PJ. The diagnostic accuracy of history, physical examination, and radiographs in the evaluation of traumatic knee disorders. *Am J Sports Med*. 1996;24(2):164–167.
48. Sandberg R, Balkfors B, Henricson A, Westlin N. Stability tests in knee ligament injuries. *Arch Orthop Trauma Surg*. 1986;106:5–7.
49. Evans PJ, Bell GD, Frank C. Prospective evaluation of the McMurray test. *Am J Sports Med*. 1993;21(4):604–608.
50. Fowler PJ, Lubliner JA. The predictive value of five clinical signs in the evaluation of meniscal pathology. *Arthroscopy*. 1989;5(3):184–186.
51. McMurray TP. The semilunar cartilages. *Br J Surg*. 1949;29:407–414.
52. Smith CC. Evaluating the painful knee: a hands-on approach to acute ligamentous and meniscal injuries. *Adv Stud Med*. 2004;4(7):362–370.

53. Jackson JL, O'Malley PG, Kroenke K. Evaluation of acute knee pain in primary care. *Ann Intern Med*. 2003;139:575–588.
54. Larson RL. Physical examination in the diagnosis of rotatory instability. *Clin Orthop*. 1983;172:38–44.
55. Malanga GA, Andrus S, Nadler SF, McLean J. Physical examination of the knee: a review of the original test description and scientific validity of common orthopedic tests. *Arch Phys Med Rehabil*. 2003;84:592–603.
56. Galway HR, MacIntosh DL. The lateral pivot shift: a symptom and sign of anterior cruciate ligament insufficiency. *Clin Orthop*. 1980;147:45–50.
57. Matsumoto H. Mechanism of the pivot shift. *J Bone Joint Surg Br*. 1990;72B:816–821.
58. Liorzou. *Knee Ligaments: Clinical Examination*. Berlin: Springer-Verlag; 1991.
59. Losee RE. Concepts of pivot shift. *Clin Orthop*. 1983;172:45–51.
60. Kujala UM, Nelimarkka O, Koskinen SK. Relationship between the pivot shift and the configuration of the lateral tibial plateau. *Arch Orthop Trauma Surg*. 1992;111:228–229.
61. Paessler HH, Michel D. How new is the Lachman test? *Am J Sports Med*. 1992;20(1):95–97.
62. Torg JS, Conrad W, Kalen V. Clinical diagnosis of anterior cruciate ligament instability in the athlete. *Am J Sports Med*. 1976;4(2):84–93.
63. Groves WEH. The crucial ligaments of the knee-joint: their function, rupture, and the operative treatment of the same. *Br J Surg*. 1920;7:505–515.
64. Galway RD, Beaupre A, MacIntosh DL. Pivot shift: a clinical sign of symptomatic anterior cruciate insufficiency. *J Bone Joint Surg Br*. 1972;54-B:763–764.
65. Akseki D, Özcan Ö, Boya H, Pinar H. A new weight-bearing meniscal test and a comparison with McMurray's test and joint line tenderness. *Arthroscopy*. 2004;20(9):951–958.
66. Hoppenfeld S. *Physical Examination of the Spine and Extremities*. Norwalk, CT: Appleton & Lange; 1976.
67. Noyes FR, Bassett RW, Grood ES, Butler DL. Arthroscopy in acute traumatic hemarthrosis of the knee. *J Bone Joint Surg Am*. 1980;62-A:687–695.
68. Solomon DH, Simel DL, Bates DW, Katz JN, Schaffer JL. Does this patient have a torn meniscus or ligament of the knee? Value of the physical examination. *JAMA*. 2001;286:1610–1620.
69. Altman R, Asch E, Block D, et al. Development of criteria for the classification and reporting of osteoarthritis: classification of osteoarthritis of the knee. *Arthritis Rheum*. 1986;29(8):1039–1049.
70. Seaberg DC, Jackson R. Clinical decision rule for knee radiographs. *Am J Emerg Med*. 1994;12:541–543.
71. Boeree NR, Ackroyd CE. Assessment of the menisci and cruciate ligaments: an audit of clinical practice. *Injury*. 1991;22(4):291–294.
72. Lee JK, Yao L, Phelps CT, Wirth CR, Czajka J, Lozman J. Anterior cruciate ligament tears: MR imaging compared with arthroscopy and clinical tests. *Radiology*. 1988;166:861–864.
73. Tonino AJ, Huy J, Schaafsma J. The diagnostic accuracy of knee testing in the acute injured knee: initial examination versus examination under anesthesia with arthroscopy. *Acta Orthop Belg*. 1986;52:479–487.
74. Braunstein EM. Anterior cruciate ligament injuries: a comparison of arthrographic and physical diagnosis. *Am J Roentgenol*. 1982;136:423–425.
75. Kostov H, Arsovski O, Kostova E, Nikolov V. Diagnostic assessment in anterior cruciate ligament (ACL) tears. *Pril (Makedon Akad Nauk Umet Odd Med Nauki)*. 2014;35:209–218.
76. Jah AAE, Kayhani S, Zarei R, Moghaddam AK. Accuracy of MRI in comparison with clinical and arthroscopic findings in ligamentous and meniscal injuries of the knee. *Acta Orthop Belg*. 2005;71:189–196.
77. Kurosaka M, Yagi M, Yoshiya S, Muratsu H, Mizuno K. Efficacy of the axially loaded pivot shift test for the diagnosis of a meniscal tear. *Int Orthop*. 1999;23:271–274.
78. Mirzatolooei F, Yekta Z, Bayazidchi M, Ershadi S, Afshar A. Validation of the Thessaly test for detecting meniscal tears in anterior cruciate deficient knees. *Knee*. 2010;17:221–223.
79. Galli M, Ciriello V, Menghi A, Aulisa AG, Rabini A, Marzetti E. Joint line tenderness and McMurray tests for the detection of meniscal lesions: what is their real diagnostic value? *Arch Phys Med Rehabil*. 2013;94:1126–1131.

80. Corea JR, Moussa M, Othman AA. McMurray's test tested. *Knee Surg Sports Traumatol Arthrosc*. 1994;2:70–72.
81. Rinonapoli G, Carraro A, Delcogliano A. The clinical diagnosis of meniscal tear is not easy. Reliability of two clinical meniscal tests and magnetic resonance imaging. *J Immunopathol Pharmacol*. 2011;24(suppl 2):39–44.
82. Yan R, Wang H, Ji ZH, Guo YM. Predicted probability of meniscus tears: comparing history and physical examination with MRI. *Swiss Med Wkly*. 2011;141:w13314.
83. Shelbourne KD, Martini DJ, McCarroll JR, VanMeter CD. Correlation of joint line tenderness and meniscal lesions in patients with acute anterior cruciate ligament tears. *Am J Sports Med*. 1995;23(2):166–169.
84. Eren O. The accuracy of joint line tenderness by physical examination in the diagnosis of meniscal tears. *Arthroscopy*. 2003;19:850–854.
85. Kastelein M, Wagemakers HPA, Luijsterburg PAJ, Verhaar JAN, Koes BW, Bierma-Zeinstra SMA. Assessing medial collateral ligament knee lesions in general practice. *Am J Med*. 2008;121:982–988.
86. Harilainen A. Evaluation of knee instability in acute ligamentous injuries. *Ann Chir Gynaecol*. 1987;76:269–273.
87. Rose NE, Gold SM. A comparison of accuracy between clinical examination and magnetic resonance imaging in the diagnosis of meniscal and anterior cruciate ligament tears. *Arthroscopy*. 1996;12(4):398–405.
88. Nickinson R, Darrah C, Donell S. Accuracy of clinical diagnosis in patients undergoing knee arthroscopy. *Int Orthop*. 2010;34:39–44.
89. Mitsou A, Vallianatos P. Clinical diagnosis of ruptures of the anterior cruciate ligament: a comparison between the Lachman test and the anterior drawer sign. *Injury*. 1988;19:427–428.
90. Jonsson T, Althoff B, Peterson L, Renstrom P. Clinical diagnosis of ruptures of the anterior cruciate ligament: a comparative study of the Lachman test and the anterior drawer sign. *Am J Sports Med*. 1982;10(2):100–102.
91. Donaldson WF, Warren RF, Wickiewicz T. A comparison of acute anterior cruciate ligament examinations: initial versus examination under anesthesia. *Am J Sports Med*. 1985;13(1):5–10.
92. Solomon DH, Avorn J, Warsi A, et al. Which patients with knee problems are likely to benefit from nonarthroplasty surgery? Development of a clinical prediction rule. *Arch Intern Med*. 2004;164:509–513.
93. Keogh SP, Shafi A, Wijetunge DB. Comparison of Ottawa ankle rules and current local guidelines for use of radiography in acute ankle injuries. *J R Coll Surg Edinb*. 1998;43(5):341–343.
94. Leddy JJ, Smolinski RJ, Lawrence J, Snyder JL, Priore RL. Prospective evaluation of the Ottawa ankle rules in a university sports medicine center: with a modification to increase specificity for identifying malleolar fractures. *Am J Sports Med*. 1998;26(2):158–165.
95. McBride KL. Validation of the Ottawa ankle rules: experience at a community hospital. *Can Fam Physician*. 1997;43:459–465.
96. Papacostas E, Malliaropoulos N, Papadopoulos A, Liouliakis C. Validation of Ottawa ankle rules protocol in Greek athletes: study in the emergency departments of a district general hospital and a sports injuries clinic. *Br J Sports Med*. 2001;35(6):445–447.
97. Pigman EC, Klug RK, Sanford S, Jolly BT. Evaluation of the Ottawa clinical decision rules for the use of radiography in acute ankle and midfoot injuries in the emergency department: an independent site assessment. *Ann Emerg Med*. 1994;24(1):41–45.
98. Pijnenburg ACM, Glas AS, de Roos MAJ, et al. Radiography in acute ankle injuries: the Ottawa ankle rules versus local diagnostic decision rules. *Ann Emerg Med*. 2002;39(6):599–604.
99. Tay SY, Thoo FL, Sitoh YY, Seow E, Wong HP. The Ottawa ankle rules in Asia: validating a clinical decision rule for requesting X-rays in twisting ankle and foot injuries. *J Emerg Med*. 1999;17(6):945–947.
100. Thompson TC, Doherty JH. Spontaneous rupture of tendon of Achilles: a new clinical diagnostic test. *J Trauma*. 1962;2:126–129.
101. Stiell IG, Greenberg GH, McKnight RD, et al. Decision rules for the use of radiography in acute ankle injuries: refinement and prospective validation. *JAMA*. 1993;269:1127–1132.

102. Stiell IG, Greenberg GH, McKnight RD, Nair RC, McDowell I, Worthington JR. A study to develop clinical decision rules for the use of radiography in acute ankle injuries. *Ann Emerg Med.* 1992;21(4):384–390.
103. Maffulli N. The clinical diagnosis of subcutaneous tear of the Achilles tendon: a prospective study in 174 patients. *Am J Sports Med.* 1998;26(2):266–270.
104. Scott BW, Chalabi AA. How the Simmonds–Thompson test works. *J Bone Joint Surg Br.* 1992;74B(2):314–315.
105. Simmons FA. The diagnosis of the ruptured Achilles tendon. *Practitioner.* 1957;179(1069): 56–58.
106. Matles AL. Rupture of the tendo Achilles. *Bull Hosp Jt Dis.* 1975;36(1):48–51.
107. Auleley GR, Kerboull L, Durieux P, Cosquer M, Courpied JP, Ravaud P. Validation of the Ottawa ankle rules in France: a study in the surgical emergency department of a teaching hospital. *Ann Emerg Med.* 1998;32:14–18.
108. Broomhead A, Stuart P. Validation of the Ottawa ankle rules in Australia. *Emerg Med.* 2003;15:126–132.
109. Yuen MC, Sim SW, Lam HS, Tung WK. Validation of the Ottawa ankle rules in a Hong Kong ED. *Am J Emerg Med.* 2001;19:429–432.
110. Can Ü, Ruckert R, Held U, Buchmann P, Platz A, Bachmann LM. Safety and efficiency of the Ottawa ankle rule in a Swiss population with ankle sprains. *Swiss Med Wkly.* 2008;138(19-20):292–296.
111. Springer BA, Arciero RA, Tenuta JJ, Taylor DC. A prospective study of modified Ottawa ankle rules in a military population: interobserver agreement between physical therapists and orthopaedic surgeons. *Am J Sports Med.* 2000;28(6):864–868.
112. Dissmann PD, Han KH. The tuning fork test—a usefule tool for improving specificity in "Ottawa positive" patients after ankle inversion injury. *Emerg Med J.* 2006;23:788–790.
113. Derkson RJ, Bakker FC, Geervliet PC, et al. Diagnostic accuracy and reproducibility in the interpretation of Ottawa ankle and foot rules by specialized emergency nurses. *Am J Emerg Med.* 2005;23:725–729.
114. Yazdani S, HJahandideh H, Ghofrani H. Validation of the Ottawa ankle rules in Iran: a prospective survey. *BMC Emerg Med.* 2006;6(3):1–7.
115. Anis AH, Stiell IG, Stewart DG, Laupacis A. Cost-effectiveness analysis of the Ottawa ankle rules. *Ann Emerg Med.* 1995;26:422–428.
116. Auleley GR, Ravaud P, Giraudeau B, et al. Implementation of the Ottawa ankle rules in France: a multicenter randomized controlled trial. *JAMA.* 1997;277:1935–1939.
117. Stiell IG, Laupacis A, Brison R, Verbeek R, Vandemheen K, Naylor CD. Multicenter trial to introduce the Ottawa ankle rules for use of radiography in acute ankle injuries. *BMJ.* 1995;311:594–597.
118. Stiell IG, McKnight RD, Greenberg GH, et al. Implementation of the Ottawa ankle rules. *JAMA.* 1994;271:827–832.